POWER

Volume 54 New York, November 15, 1921 *Number* 20

Root, Branch and Fruit

AT a dinner recently tendered to a party of distinguished engineers returning from a mission of comity and good fellowship to the engineering societies of Europe, Mr. Ambrose Swazey, the chairman of the commission, in a few words presented a big idea.

He likened the growth of industry, of civilization, of the mastery of man over his environment, to that of a tree. Its roots, feeling their way through the mysteries and possibilities of Nature, are Research. Incited and stimulated by discovery, new shoots spring up, new branches put forth, and in their fruits the world is made richer and the race more potent by new industries, new materials, new methods of defense against disease, and other munitions for racial development.

The analytical mind of James Watt is directed to a model of the crude steam engine of Newcomen. The root of research sends out a new shoot, and the tree of industry is given another source of vigor. Human muscle is relieved of the irksome stress it carried, thousands of new processes become possible, hundreds of problems of transportation are solved, the struggle of the race for existence is lightened, and the comfort, convenience, security and enjoyment of the average human being are raised to a higher plane.

Great indeed have been the fruits of that rootlet and its ramifications. It is easy to follow in thought the sprouting and development of others. It is good to contemplate the great tree of industry and art and culture and civilization that has arisen from them. Its branches sometimes get into each other's way. Wise and intelligent pruning may be beneficial and even necessary. The torch and the spray may have to be applied to blighting parasites and irresponsible insectivorous enemies. There are even those who would wantonly destroy a new and promising branch lest it overshadow or crowd their own. But daily the bigger conception is gaining ground that the more fruit the tree bears the more there will be of it for the race as a whole and for every individual of it.

F. R. Low

Consumers Central Heating Company's New Hog-Fuel Burning Plant

IN THE great Pacific Northwest much progress has been made in recent years in the utilization of lumber-mill waste for steam generation. Located in or in close proximity to Portland, Oregon, Tacoma and Seattle, Wash., as well as other smaller cities, are scores of lumber-manufacturing plants. Before use of the waste product was made for steam purposes, the disposition of this enormous amount of material was a problem. Large incinerators or open fire pits was the manner in which the waste product was destroyed, and instead of the lumber manufacturer realizing any profit on it, he was put to considerable expense in the installation and maintenance of sawmill burners. At the left of Fig. 2 is shown one of these large burners that has been abandoned, the waste now being ground up and conveyed to barges by conveyor shown in the foreground. The disposition of sawmill waste for steam purposes is not all profit for the sawmill operator, as considerable investment is required for machinery and conveying apparatus. A large amount of power is required to drive the hogs, and the maintenance of the equipment is a considerable expense as well as the operating labor.

Sawmill refuse, commonly known as hog fuel, consists of sawdust, shavings, ground-up edgings, slabs and trimmings. Hog fuel, on account of its greatly varying moisture content, is not sold by weight but by volume, and a unit of 200 cu.ft. has become the standard term for its sale and handling. The weight of a unit of hog fuel varies from 1½ to 2¼ tons and the amount of steam that can be generated per unit is from 7,500 to 12,000 lb., depending on the kind of wood and the moisture contained therein. Hog fuel is bulky, and in order to handle it economically, proper handling and conveying facilities must be provided.

Some steam stations are fortunately located near sawmills where the hog fuel can be handled by conveyors direct; other plants depend on trucks, railroad cars or barges for transporting their fuel supply. Of the three last-named methods the barge is the cheapest, owing to the large quantity that can be handled. The amount of hog fuel a barge can carry varies from 100 to 250 units. The average railroad hog-fuel car will handle 18 units and a motor truck 1 to 2 units.

The Consumers Central Heating Co.'s new district-heating steam plant, at Tacoma, Wash., is somewhat out of the ordinary inasmuch as the plant has been designed and built for the use of wood fuel only, there being no coal or oil stand-by provided.

> Hog fuel, consisting of sawdust, shavings, ground-up edgings, slabs and trimmings, is purchased from lumber manufacturing plants for fuel, there being no provision for burning other fuels. Three 7,500 sq.ft. vertical water-tube boilers are installed, with space for an additional unit. Fuel is delivered by barges and is handled by a 5-ton electric monorail-operated clamshell bucket to a system of conveyors, which discharge to storage bins from which it is fed to the dutch-oven furnace of each boiler. This fuel, which was formerly a charge against the lumber mills for disposal, is now sold at a profit and the heating plant also benefits by using a cheap fuel.

The boilers have furnaces that allow of 300 per cent continuous rating. Indicating and recording instruments have been provided. The operating labor required for this plant compares favorably with a similar sized stoker-fired coal-burning plant. The headpiece shows an exterior view of the station located on a waterway connecting with Puget Sound, and a portion of the business and industrial district it serves with high- and low-pressure steam.

The isometric diagram, Fig. 1, shows the methods of handling fuel from barge, car or truck, also the provision of grinding up slabs in storage should the hog-fuel supply fail. Although provision has been made for transporting hog fuel to the plant in the various ways mentioned, the main supply is handled from the large mills of the St. Paul & Tacoma Lumber Co. by barges, a distance of approximately two miles. A sufficient number of loaded barges are always kept ahead of the plant's consumption, and the main storage is handled in this manner. A storage bunker of 200-units capacity is located in the plant; however, this is intended for emergency and light-load periods.

A five-ton electric monorail hoist, equipped with a 1½-yd. electrically operated clamshell bucket is used to remove the hog fuel from the barges. Fig. 3 shows the monorail unloading apparatus as well as two barge-loads awaiting unloading. The movement of a barge is

handled by winch controlled from the operator's cab above the clamshell bucket and can unload and clean up a scow with no other assistance.

The clamshell bucket discharges onto a 30-in. belt conveyor, running at an incline of 25 deg., as shown in Fig. 4. This belt conveyor discharges to a cross 30-in. belt conveyor from which it unloads onto the upper run of a 30-in. double, steel-type, chain and scraper conveyor. Openings in this conveyor are connected to steel chutes which allows the fuel to flow to the furnaces. Rack-and-pinion slide gates actuated from the firing deck control the amount of fuel required. The fuel passing over the top run of the steel conveyor, which is in excess capacity of that required by boilers, drops through openings in the rear end of the conveyor to the bottom run and is distributed through slide gates to fuel bunkers located directly below.

A separate conveyor for each boiler connects the lower part of bunker with the furnaces. Bulkheads in the bunker provided with doors allow these conveyors to be loaded properly with a minimum of labor. Conveyors as shown by Fig. 1, of the drag-chain and cable type, are provided for handling fuel from cars, trucks or hog to the inclined-belt conveyor. The conveyors are driven by specially designed back-geared twin engines, which are provided with variable-speed governors for the purpose of running the conveyors at a speed to suit the load conditions on the plant. A signal system is used whereby the monorail operator is kept informed by the firemen as to the amount of fuel required at all times.

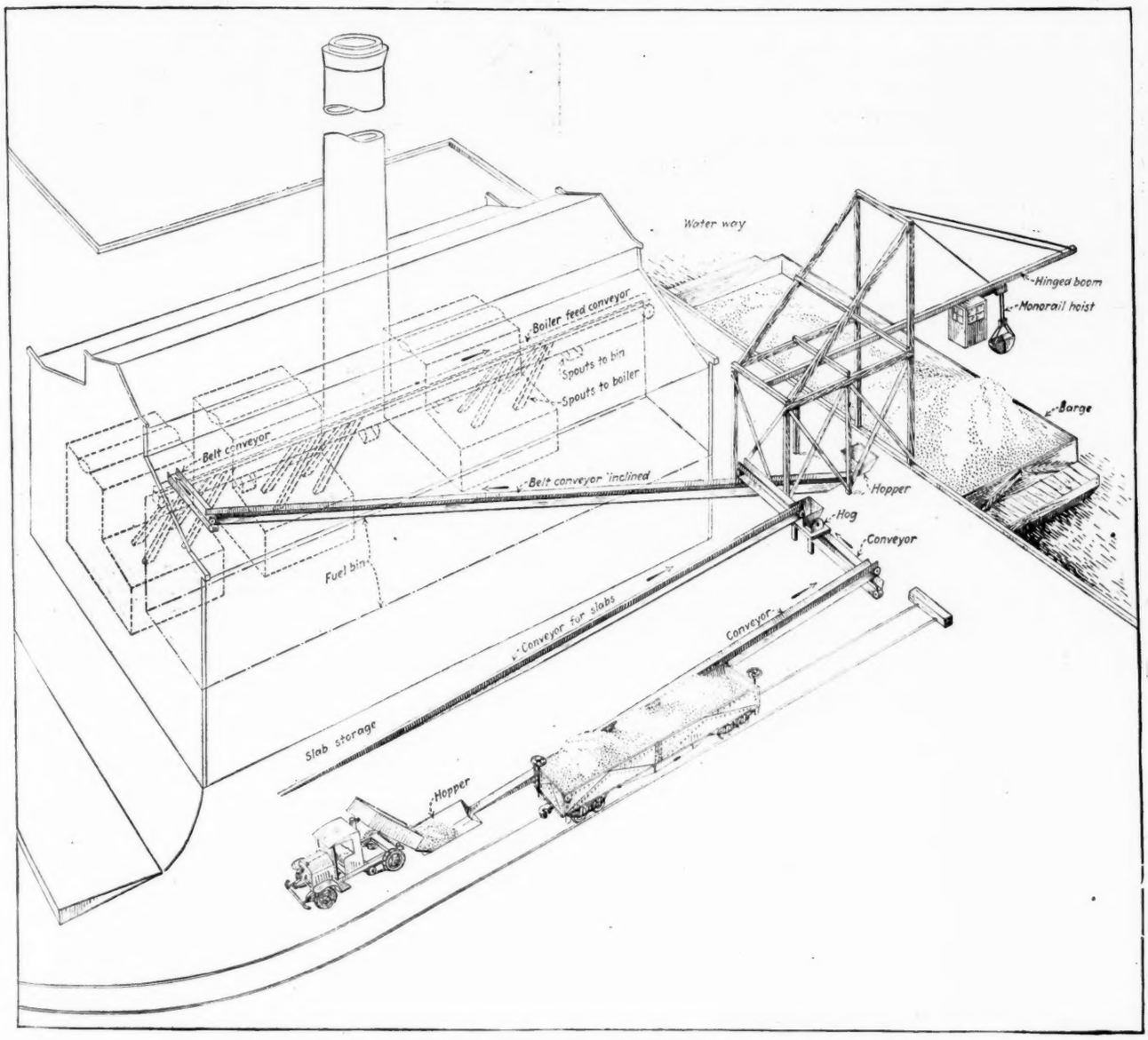


FIG. 1. ISOMETRIC DIAGRAM OF THE FUEL-HANDLING SYSTEM

Three 7,500-sq.ft. vertical-type water-tube boilers have been installed; however, the plant has been designed and provision made for four units. Each boiler is set single and each contains a total of 532 three-inch tubes, there being 14 rows, 38 tubes wide. The boilers are of A. S. M. E. construction for 200 lb. pressure, but are being operated for the present at 150 lb. The three boilers are served by a steel breeching which connects with a 10-ft. diameter by 200-ft. radial-brick

stack. The dampers, which are in the uptake of each boiler, are controlled by a 5-in. master regulator actuated by the flow of steam from the boilers. The steel breeching is lined with 1 in. of vitrobestos, mainly for the purpose of saving the steel from early destruction and to reduce heat radiation. Each boiler is equipped with steam soot blowers, there being five elements on each side of each boiler.

An indicating steam-flow meter is mounted on the front of each boiler, the graphic recorder and integrator being in the chief engineer's office, where also are flow meters for the measurement of the steam used by the station auxiliaries and of the steam leaving the station through a 12-in. main. Flue-gas temperatures are recorded by three electrical pyrometers. Three CO_2 recorders, graphic recorders for feed-water and steam temperatures and steam pressure are also located in the chief engineer's office, a partial view of which is shown in Fig. 5.

Feed water is furnished by an open-type feed-water heater to which is connected the suction lines of two four-stage centrifugal pumps, each directly connected to a steam turbine. The two turbine feed pumps discharge into a 6-in. main header to which the boilers are connected by 3-in. branch lines. Feed-water supply to each boiler is controlled by a feed-water regulator. Exhaust from the four conveyor engines, the feed pumps and also the discharge from several steam traps are piped into an open-type feed-water heater.

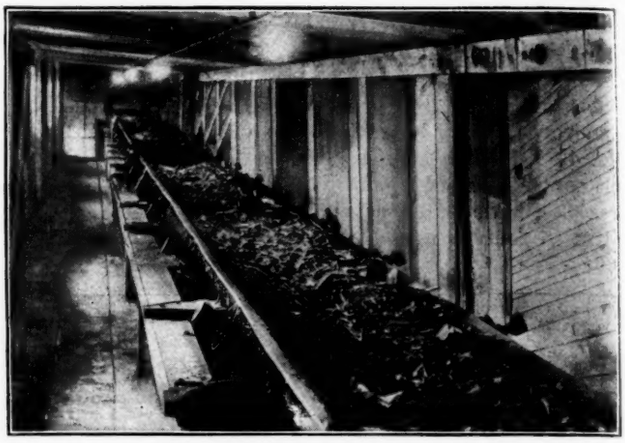


FIG. 4. THIRTY-INCH BELT CONVEYOR CARRYING FUEL FROM BARGE TO PLANT

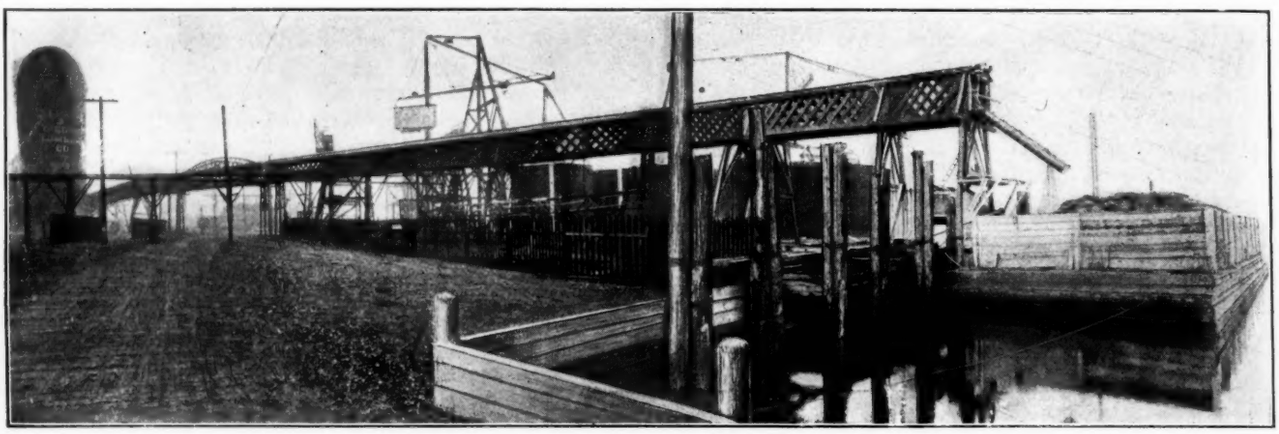


FIG. 2. CONVEYOR HANDLING HOG FUEL FROM SAWMILL TO BARGES

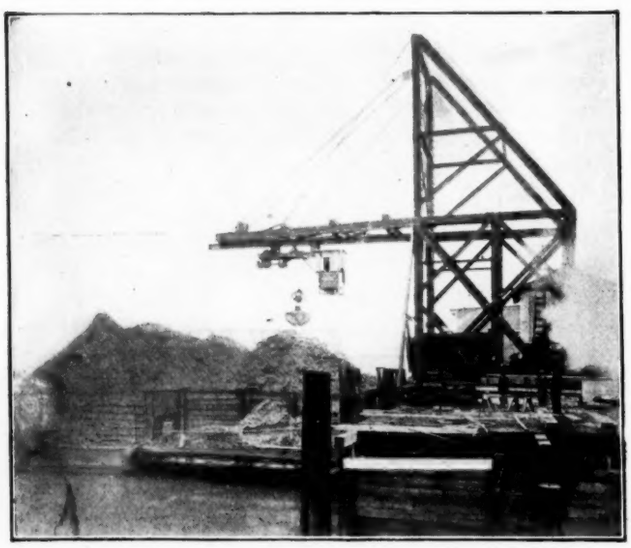


FIG. 3. MONORAIL HOIST AND ELECTRICALLY OPERATED CLAMSHELL BUCKET

The steam outlet from each boiler is 10 in. and is connected with 12-in. main header through an automatic stop check valve, gate valve and horizontal long-sweep bend. All live-steam and feed-water piping is of extra-heavy flanged construction and is insulated with sponged felt covering.

Each of the three boilers is equipped with a large dutch-oven type furnace, being 19 ft. long by 18 ft. 9½ in. wide, inside dimensions. A side elevation of one of the units is shown by Fig. 6.

The plant being near the retail business district, it was essential that no smoke or cinders be emitted from the stack, therefore considerable thought was given the furnace design. The furnaces have worked out exceedingly well, and practically no smoke is ever seen coming out of stack and the boilers are able to maintain a 300 per cent rating with green fir sawmill refuse. Each furnace contains 225 sq.ft. of stationary bar gates, provided with ½-in. air spaces.

The ashpits are of the depressed type and are kept flooded with water to protect the grates. They connect with an ash sluiceway running the length of the boiler room, and the ashes are sluiced into a fill that is being made at the rear of the plant. The amount of ash from

hog-fuel burning plants is small as compared to coal fired plants.

The front and side walls of the furnaces are 18 in. thick, 9 in. of common and 9 in. of fiebrick. The furnace walls and the front bridge wall are laid up in high-temperature cement, a different brand being used in each of the three furnaces in order to obtain data as to quality.

The main bridge wall is at the end of the 12-ft. grate length and is provided with a large duct with branch openings at the top for the admission of secondary air, the supply of which is controlled by adjustable dampers located in both side walls at the point of the bridge wall. The rear bridge wall is located against the mud drum and it is also provided with ducts for secondary air admission. The space between the two bridge walls forms a large chamber where nearly complete combustion takes place prior to the gases coming in contact with the boiler-heating surface.

The entire furnace is covered by a flat-suspended fire-tile arch. Each arch inclines from a furnace front to the boiler 18 in. for the purpose of providing greater combustion space at the rear. The arch spans the furnace from side wall to side wall and no center or division wall is used.

A $\frac{3}{16}$-in. steel-plate deck covers the structural steel supporting members of the arch and is arranged in sections so that the arch tile are easily accessible at any time for renewals. The side walls are built up to the point where the structural-steel supporting members rest, and the space between the top of the walls and the steel deck is left open for ventilation. A 2-in. iron-pipe railing surrounds each furnace deck, and from this deck the firemen handle all controls of fuel, etc. The fuel enters each furnace through four cast-iron water-cooled thimbles which are inserted in the arch. Cooling water enters each fuel thimble through a $\frac{1}{2}$-in. pipe and discharges through a $\frac{3}{4}$-in. pipe to the open feed-water heater.

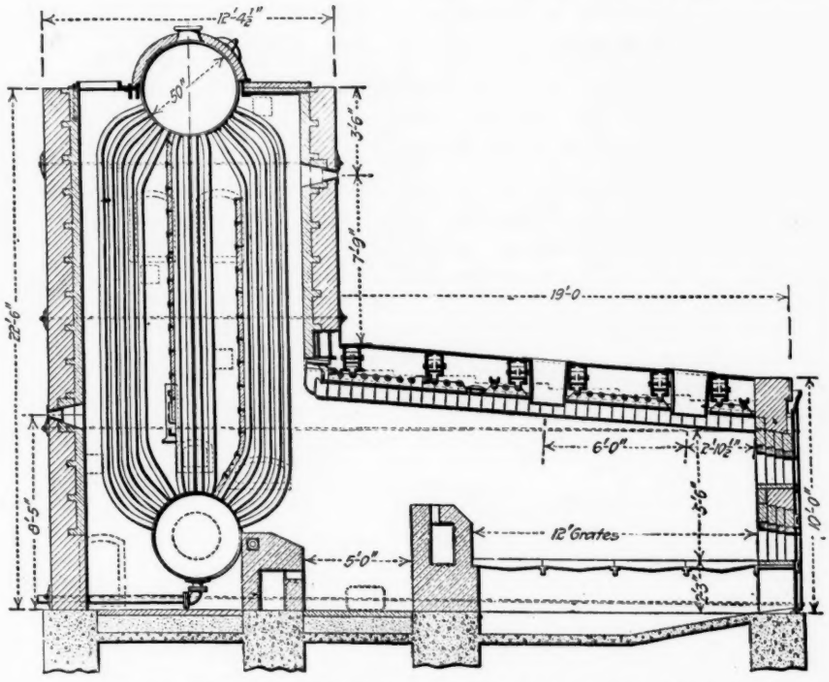


FIG. 6. SECTION THROUGH ONE OF THE BOILER UNITS

The design and erection of the entire plant was under the direct supervision of R. L. Watts, a member of the engineering firm of Lewis & Watts.

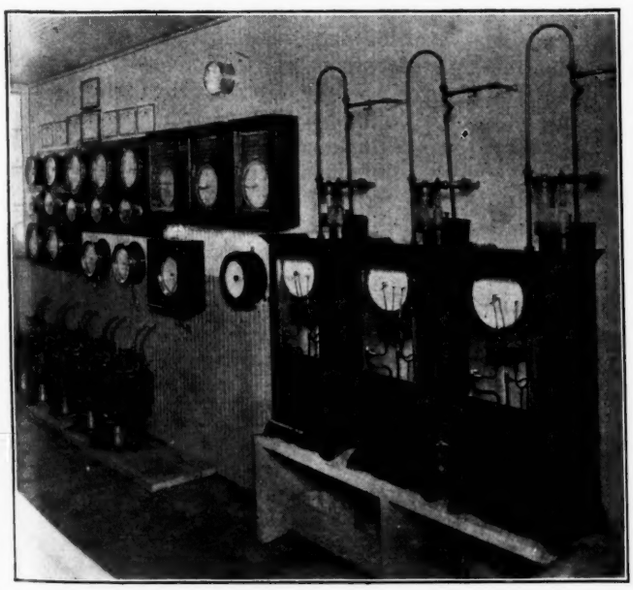


FIG. 5. INSTRUMENTS IN THE CHIEF ENGINEER'S OFFICE

Defrosting Cooling-Room Coils

By D. A. Fanan

A refrigerating plant consisting of a combined ice and cold-storage system, called upon me for assistance. On reaching the plant, I was informed that for some reason the cold-storage rooms could no longer be kept at the proper temperature. In spite of speeding up the compressor and increasing the opening of the expansion valves, the temperature still stood around 20 deg. higher than normal.

We started to investigate and, as a beginning, visited the cold-storage rooms. The coils, which were of the direct-expansion type, were coated with at least three inches of frost; the outside diameter instead of being two inches, the coil size, was at least eight inches. My suggestion that if the frost was eliminated the cooling effect of the pipe coils would be restored was not agreed to by the engineer. He claimed that with the pipe bare the outside circumference of the coil was approximately 6.25 in., making the cooling surface about one-half a square foot per running foot of coil. With the frost on, he stated, the outside circumference was about 24 in., giving two square feet of surface per running foot of coil. It was impossible to convince him by argument that the iron pipe would absorb more heat per square foot than would the frost. His argument was that if the iron pipe absorbed a certain amount of heat from the air, then it would absorb more heat from the compact frost around the pipe; the frost in turn, he felt,

would take up heat more rapidly from the air than would the iron pipe.

It was useless to argue the question, so I arranged to defrost the coils by pumping hot gas into each coil in turn. No arrangement for such a line had been made in the plant when installed, neither was there a pump-out line. Since means should be provided to enable any coil to be emptied while the other coils were in service, the management agreed to the plan of installing a hot-gas and pump-out header.

This head was provided with a tee-connection at each coil. The joint between the coil and expansion valve was opened and a tee inserted. This tee, together with a valve and two nipples, made the connection to the hot-gas header. A 2-in. pipe line was run from this header to the compressor discharge line between the compressor and condenser. A line was also run to the main suction line. In this way the expansion valve on any coil could be closed and the coil emptied by opening the connection to the hot-gas line and to the suction line.

When all the parts were put together, the valve between the hot-gas head and the compressor discharge line was opened. The expansion valve on one coil was closed and the header valve opened. The hot discharge gas now passed through the header into the coil and rapidly melted the frost. This process was followed on each coil, and soon the pipes were clean. Upon running the plant awhile the improved cooling action was decidedly noticeable.

The chief danger occurs in the defrosting process when the hot-gas valve is first opened. If the coil is full of liquid, the hot-gas pressure will quite likely throw some liquid into the suction line. For this reason a man should be stationed at this valve to close it at the first sound of liquid striking the compressor.

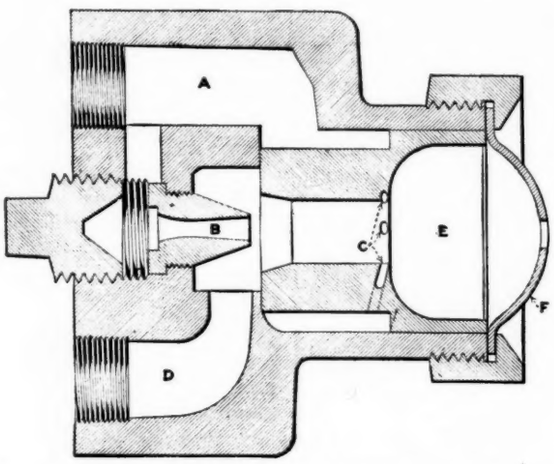
After the job was finished, the engineer agreed that the plant was working better with the pipes bare. But he insisted on having it explained to him. I showed him that the flow of heat through the iron pipe which is $\frac{7}{16}$ in. thick was about 10 British thermal units per square foot of surface per hour. If, on the other hand, the iron pipe walls were as thick as the frost, or three inches, the rate of heat transmission would be closer to 5 B.t.u. per hour. But the frost really transmitted heat faster than iron of the same thickness so that the frost transmitted around 8 B.t.u. per square foot. However, three inches of frost compared to the usual iron-pipe thickness makes the latter more efficient as a transmitter of heat.

Enco Oil Burner

With the Enco oil burner any desired shape or size of flame may be obtained. The most important advantages gained by the burner are facility for burning low-gravity oil in both large and small quantities with minimum oil and steam or air pressure and the ability to produce a flame of any size or shape.

The burner, which is of the inside mixing type, consists of six parts—a body, a base piece, a venturi nozzle, a plug, an interchangeable flame plate and a nut. The arrangement of the venturi nozzle in its relation to the longitudinal hole creates an effective injector, which permits heavy oils and tars to be fed to the burner at low pressures. Fuel is not driven through the flame plate at a high velocity, as the driving force of the jet entering through the venturi, while sufficient partly to atomize the fuel, is expended before it reaches this chamber. The action of the tangential jets is practically exhausted by the whirling motion within the mixing chamber, and the atomization is thus completed before the mixture passes through the flame plate. The fuel is therefore ready for combustion upon leaving the burner.

The steam or air inlet *A* leads to the center of the burner and then through the venturi nozzle, into the annular space around the plug and through the tangential openings *C* into the mixing chamber. The venturi nozzle *B* passes the steam or air forward, meeting the fuel



SECTION THROUGH ENCO OIL BURNER

at its mouth and beginning the atomizing process as the fuel is carried toward the mixing chamber. The steam or air passes through the annular space surrounding the mixing chamber through the tangential holes in the plug and sets up a rapid whirling motion. The partly atomized fuel is picked up at the entrance of the mixing chamber and atomized by the action of the tangential jet.

Oil flows under low pressure to the fuel chamber at the mouth of the venturi nozzle, where it comes in contact with the steam or air jet to the nozzle which carries the fuel toward the entrance of the mixing chamber *E*, to which the partly atomized fuel is carried by its own pressure and that of the steam or air jet from the venturi nozzle. Atomization is completed inside the mixing chamber by the jet entering through the holes in the plug. The flame plate *F*, in which are cut slots or holes to secure a flame of the desired size and shape, is interchangeable for a plate cut to any other pattern. The gasified oil is forced through the flame plate, where it is atomized and ready for combustion.

The smallest oil passage is $\frac{3}{8}$ in. in diameter, and the absence of oil near the face of the burner prevents a deposit of carbon. The flame plate can be changed by removing one nut. The burner is readily put in operation by any pipefitter, as there are but two connections to be made, one for steam and one for oil.

This device is manufactured by the Engineer Co., 17 Battery Place, New York City.

The table of equipment accompanying the description of the new Ford power plant at River Rouge in the Sept. 6 issue, was incomplete in that only one make of soot blowers was mentioned. We have since been advised that several of the boiler units are equipped with Diamond soot blowers.

Locating Electrical Trouble on Elevators

Grounds, Short-Circuits and Open Circuits Defined—Methods of Grounding Power Systems—Examples Given on How to Locate Electrical Faults on Controller Equipment

BY WILLIAM ZEPERNICK

IN ELECTRICAL trouble hunting it is necessary to be familiar with the characteristics of the power system and the operation of the equipment at fault. This generally constitutes a large percentage of the work involved to remedy the difficulty. It is usually a simple matter to remove a ground or short-circuit and to correct an open circuit. There are many ways to test for these various troubles, depending principally upon the power system and method of grounding same. Before going into this, it is well to have an understanding of what a ground, short-circuit and an open circuit are. A ground is a condition under which an electrical path is provided from the devices involved to the earth, and may be modified by specifying a low- or a high-resistance ground, depending upon how good a contact the circuit makes with the earth. When speaking of a circuit as being grounded, when there is no electrical circuit to the earth, the statement should be modified by indicating to what the circuit is electrically connected. For example, assume that a magnet coil mounted in a frame, as in Fig. 1, has its insulation punctured, permitting the bare wire to touch the core at *X*. In this case, if the frame is insulated from the earth, as when mounted on a panel board, and does not have an electrical path to the earth, through grounded conduit or otherwise, it should be stated that the coil is

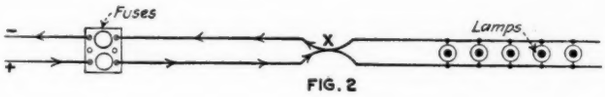


FIG. 2

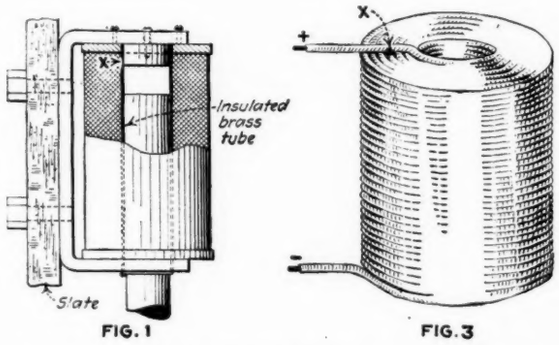


FIG. 1 FIG. 3

FIGS. 1 to 3. SHOW HOW GROUNDS AND SHORT-CIRCUITS OCCUR

grounded to the frame. Under this condition the only part of the circuit involved would be the coil, and if ground to the frame at one point only, no ill effects would result, even if the main circuit were grounded.

A short-circuit is a low-resistance path which permits current to be bypassed around the unit or circuit involved. In Fig. 2, if insulation was defective and the two wires came into contact with each other, as at *X*, a circuit of low resistance would be formed, shunting the lamps out of circuit and causing the fuse to blow. It must be understood that a short-circuit does not necessarily blow fuses, as is the popular opinion, for in the case of a short-circuited armature coil, the fault manifests itself by heating the defective coil and eventually burning it out.

The magnet coil, Fig. 3, consists of a larger number of turns of small wire, with the lead from the inside turns brought out across the ends of each layer in the coil. It sometimes happens that the insulation fails be-

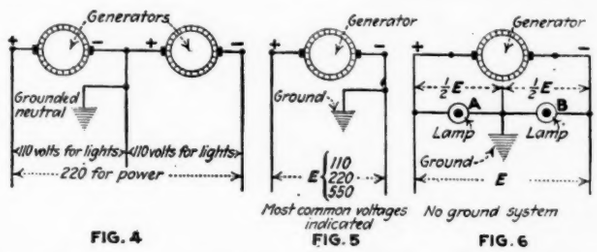


FIG. 4 FIG. 5 FIG. 6

FIGS. 4 to 6. METHODS OF GROUNDING DIRECT-CURRENT SYSTEMS

tween this lead and one or more of the layers; for example, at *X*. When this occurs, part of the coil is short circuited out of circuit—in this case the layers between the fault and the inside layers of the coil. The circuit is now not through all the turns, but from the + lead to the fault and through the outer layers of the coil to the negative lead. If a sufficient number of turns are left in circuit in this portion of the coil, they will offer enough resistance to the flow of current to prevent the fuse from blowing. However, this trouble will manifest itself by heating, as a larger amount of current will flow on account of the reduced resistance. This heating may be great enough to burn out the coil.

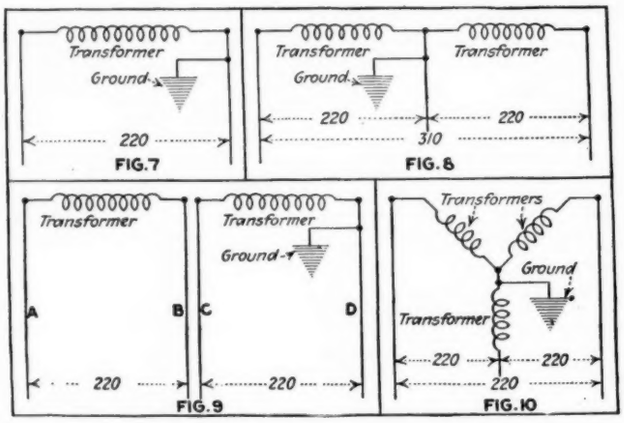
An open circuit is a condition under which the electrical path is interrupted. A loose connection frequently provides such a poor contact that it is an open circuit. In other cases it manifests itself by heating at the loose or poor connection. This heating is due to the resistance of the connection and is proportional to I^2R, where I is the current, in amperes, flowing through the connection, and R is the resistance, in ohms, offered by the connection. As the resistance is concentrated at the faults, the heating also is concentrated, thus accounting for the high temperature experienced at loose connections.

A large number of direct-current power systems have one grounded feeder. This feeder is grounded at the power station and permits a circuit to be formed from the ungrounded conductors to the earth. This does not necessarily mean that a good circuit is obtained by applying a wire to the surface of the ground; in this case this would provide a high-resistance ground. To obtain a low-resistance ground, the wire must be connected to a water line which extends through the earth for a considerable distance or to a copper plate that is properly buried in the earth.

The most common of direct-current power systems is

the three-wire with grounded neutral wire. This system was derived originally from two 110-volt generators connected in series, with the neutral wire connected between the two generators, as in Fig. 4. In Fig. 5 is shown a ground on one side of a two-wire system.

A ground detector used in a great many isolated plants using 110 or 220 volts is indicated in Fig. 6, which is an ungrounded system. Lamps *A* and *B* are



FIGS. 7 TO 10. METHODS OF GROUNDING ALTERNATING-CURRENT SYSTEMS

Fig. 7—Ground on one side of single-phase system. Fig. 8—Ground on middle wire of a three-wire two-phase system. Fig. 9—Ground on one phase of four-wire two-phase system. Fig. 10—Ground on neutral of three-phase system.

for a voltage equal to that of the line and connected in series across the circuit, therefore they will burn at half voltage. Should a ground develop on either of the two lines, that lamp which is connected to the grounded line will be short-circuited by the ground connection and will go dark, while the other lamp will burn at full brilliancy. This holds true only for a low-resistance ground; a ground of a comparatively high resistance will cause the lamp connected to the grounded feeder to burn at a lower brilliancy than the other. A ground that might appear in a motor winding or an electrical controller could also cause such a condition on account of the resistance of windings that might be involved between the feeder and ground. On alternating-current systems the most common systems used in practice, along with the method of grounding them, are shown in Figs. 7 to 10.

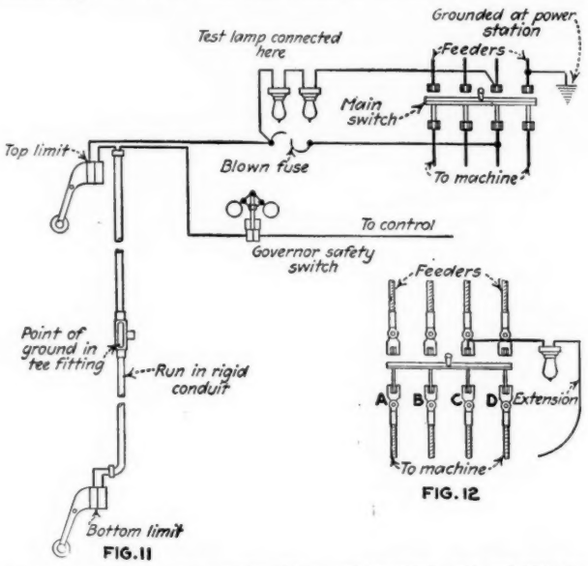
In testing for grounds on any equipment, if it is not known just what section of circuit is in trouble, it is advisable to open the main-line switch. Then by means of a voltmeter or test lamp suitable for the voltage involved, determine the grounded feeder, if any. This is done by connecting one end of a lamp or voltmeter to ground and touch each feeder in turn. In all cases with the exception of Fig. 9 the feed wires which will not produce a light or deflect the voltmeter are grounded feeders. In Fig. 9 feed wires *A* and *B* of the two-phase four-wire system will not produce a light to ground, as this phase is not grounded. Feeder *C* will indicate a light, but feeder *D* is grounded and gives no indication.

After determining which feeder will light the lamp to ground, connect the test lamp to it as indicated in Fig. 12 and touch points *A*, *B*, *C* and *D* in turn. Should the lamp burn, it will indicate that particular wire is grounded or the circuits or wiring leading from this line are grounded. Where these feeders go through conduit, it is a simple matter to go to the other end and make a similar test. There may be several connections leaving a common binding post where the feeder is connected; these may be disconnected one at a time until the grounded circuit is indicated by extinguishing the light, when the defective circuit is removed from the binding post.

In the case of more than one feeder indicating a light, it would necessarily be a case of a ground existing in a circuit extending between the two feeders, and it is advisable to follow the feed wire from which the greater brilliancy of light is obtained.

After the particular circuit that is grounded has been determined, the light may be permanently connected to the grounded circuit. This circuit should then be followed along, disconnecting preferably at some halfway point. Should the light go out, the ground is in the half of the circuit farthest away from the lamp. This half of the circuit may be further subdivided until a point is reached where opening one end of a section of the circuit puts out the light and opening the other end permits the light to burn. The ground is then located on this section of wire.

The foregoing method was used in a case of trouble on a two-speed alternating-current elevator receiving power from a two-phase four-wire 40-cycle 440-volt system. The trouble manifested itself by blowing an auxiliary fuse; this, of course, in itself indicated that the circuit connected to this fuse was grounded, permitting an abnormal current to flow through the fuse to ground and then back to the transformer. A test set consisting of two 220-volt lamps connected in series



FIGS. 11 and 12. TESTING FOR GROUNDS ON ELEVATOR-CONTROL CIRCUIT

was connected permanently to the feeder, which provided a light from it to ground. The circuit involved is shown in Fig. 11 and included the shaft-limit and governor-safety switches. The blown fuse was removed and the test set connected as shown. The contact on the governor safety switch was opened, which did not affect the burning of the lights; the bottom limit switch was then opened, but did not affect the lights. Immediately upon opening the top limit, the lights went out because the circuit to ground was interrupted. This located the trouble as existing between the top- and bottom-limit switches, and it was found that by pulling on the wires extending between these switches, it caused a flickering of the lights. An examination of the tee fitting in the

conduit showed that the wires had been spliced and the splice allowed to rest on the inner edge of the fitting. The weight of the wire cut through the insulation and grounded the conductor to the conduit.

Open circuits manifest themselves by failure of that circuit to function, with the exception as previously stated in the case of armature coils. In the case of trouble, provided there has been no dangerous condition obtained, observe the operation of the apparatus. Should the equipment fail to function, determine if there is power by testing across the feeders with a lamp and if any fuses are blown. Should there be power available and the apparatus fails to operate, it will be necessary to look for trouble on the initial circuit called upon to operate.

Any electrical equipment will generally have more than one circuit, and each circuit will be called into operation in proper order. It is only necessary to know the sequence of operation and to observe at what time in the operation trouble occurs. The circuit that is brought into operation at the time of the trouble is the circuit in difficulty, and this confines the fault to a definite part.

When starting up an electrical elevator, if there is a magnetically operated switch that should normally pull in but does not operate, a test set can be used and connected from a live wire to the terminals of magnetic coil and in this way it can be determined which of the terminals are alive, if any. This is shown by the lighting of the lamp or indication of a voltmeter. Of course current will flow through the coil, so that some indication will be obtained at both ends, if it is not open, but the side that gives the greater brilliancy is the circuit that is closed. The trouble in this case will then be confined to the other wire, which should be carefully followed throughout its path, short-circuiting sections of it, until the open circuit is jumped out, at which

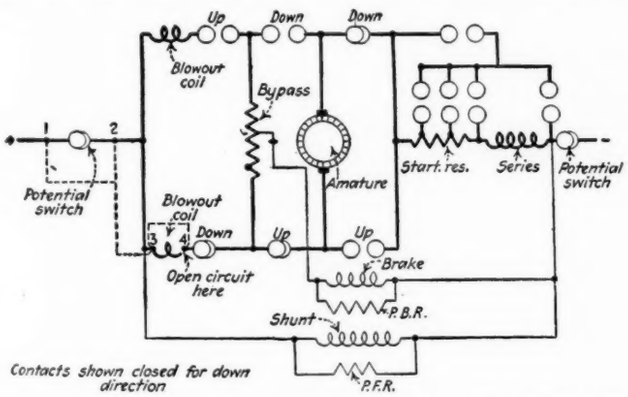


FIG. 13. DIAGRAM OF POWER CIRCUITS IN ELEVATOR CONTROLLER

time the trouble can be eliminated. This method was used in the following case of trouble:

An elevator magnet controller would operate the motor in one direction only. In the opposite direction, while the switches would function the motor would not turn. Knowledge of the equipment immediately suggested that the trouble was on the main motor circuits and located between the controller and motor. As the motor operated satisfactorily in one direction, the connecting leads between motor and controller could not be at fault; therefore, the trouble must lie in the reversing switches. A jumper wire about two feet long was skinned at each end. This jumper was utilized to bridge contacts and connecting leads on the reversing switches until the open circuit was bridged as indicated in Fig. 13, with the operator holding the car switch to the start position. From points 1 to 2, 2 to 3 no indication was received; as soon as the jumper was placed from 3 to 4 the open circuit was eliminated and the motor started. The trouble was due to a loose connection on the blowout coil, the nut that held this terminal tight having worked loose. The nut had slacked off sufficiently, and the wire with which the blowout coil was wound had enough

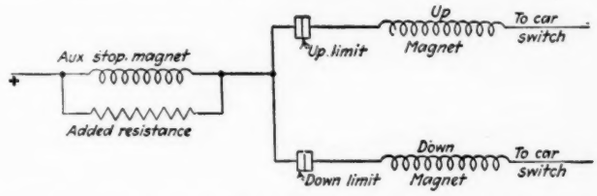


FIG. 14. REVERSING-MAGNETS AND AUXILIARY-MAGNET CIRCUIT DIAGRAM

spring to clear it from the terminal stud and nuts, thus causing an open circuit. If the one making the test is not sure of what he is doing, it will be safer to use a test lamp to bridge sections of the circuit. When the open is bridged, the lamp will light.

Short-circuits manifest themselves by blowing fuses, excessive heating of parts, or failure of short-circuited devices to operate.

The amount of current flowing through a circuit is determined by the resistance contained in that circuit. Should a portion of the circuit be shunted, there still might be enough resistance remaining to prevent sufficient current flowing to blow the fuse. However, the portion of the circuit shunted out will not function because the current will be bypassed by the short-circuit, while the current heating in the other portion of the circuit will be increased.

In the field windings of a motor when the coils have different temperatures—that is, one is cold while the others are hot—it is the cold coil that is in difficulty or short-circuited. For this reason, when a magnet coil which normally operates cool, suddenly develops heat, the trouble is caused by a portion of the coil's turns being short-circuited. A condition might exist where two or more magnets together with resistance are connected in series. With this condition one of the coils might be short-circuited without materially increasing the current if the resistance of the coil is relatively low compared to that of the entire circuit. This will not cause any serious increase in the heat developed but will prevent the faulty coil or magnet from operating.

On an elevator controller two magnet coils were connected in series; one of these operated a heavy reversing switch, while the other operated a comparatively light auxiliary switch. Trouble was experienced with the up-and-down-motion switches failing to operate at times. This was due to an increase of resistance of the coil with a rise in temperature, which decreased the value of current flowing. To insure the operation of this switch, the auxiliary-magnet coil was bypassed by a high-resistance, as in Fig. 14. This permitted some current to be shunted around the coil on the small switch, but still permitted sufficient current to flow through this coil to operate the switch. The combined current of the auxiliary coil and resistance element flows through the up-and-down-magnet coils, permitting a stronger pull for the comparatively heavy switch.

Heating and Its Relation to Isolated-Plant Operation

By E. L. WILDER*

A LARGE percentage of the private plants with which central stations are in competition are non-condensing steam plants which use a certain amount of their exhaust steam for heating and occasionally for industrial processes. Such a method of operation, under favorable conditions and during the time when there is a sufficient demand for steam to use all or a large part of the available supply, may give a low cost for the combined supply of power and steam.

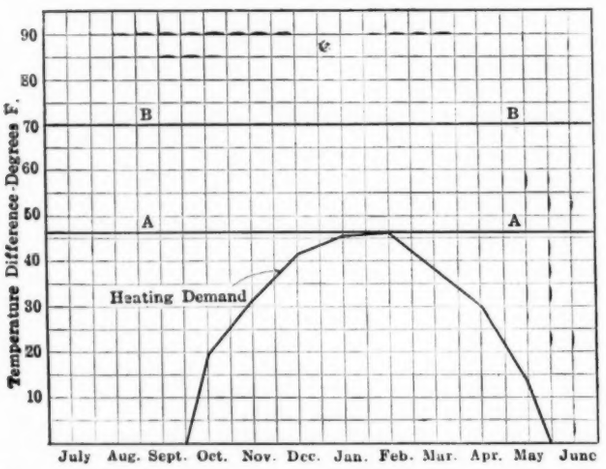


FIG. 1. AVERAGE HEATING-DEMAND CURVE FOR A CITY IN CENTRAL NEW YORK

This curve gives the average amount by which the temperature of the building must be raised above that of the outside air at different periods throughout the year. Line *AA* represents the average temperature difference for February, being about 47 deg. F. Line *BB* represents the maximum temperature difference for February, being 70 deg. F.

The extent to which exhaust steam is used for heating is often greatly exaggerated in the mind of the owner and operator of the plant, and one often hears the statement that power costs nothing during eight or nine months when steam is needed for heating. This attitude of mind can be properly dealt with only by a careful analysis of the facts and their presentation to the interested parties.

The factors that make for efficiency in the operation of a combined power and heating plant should be thoroughly understood and the conditions that make for inefficiency should be carefully analyzed.

The demand for steam for heating purposes extends over a period of seven to nine months according to the location of the plant, but is far from uniform during the heating season.

Fig. 1 shows the heating demand based on the average temperatures, according to the official weather bureau, for a city in central New York, and upon the assumption that an inside temperature of 70 deg. is maintained.

It is evident that if there be a constant supply of exhaust steam equal to the average February demand, which is represented by the line *A* on the curve, there will be a considerable waste of steam during other months of the year. As a matter of fact, only 47 per cent of the steam is used and the balance wasted. If there should be a supply of exhaust steam sufficient to take care of the heating demand during the coldest winter day, say, zero degrees Fahrenheit, represented by the line *BB* on the curve, there will be a much larger waste, only 31 per cent of the total exhaust steam being used for heating.

The foregoing is true of course for average conditions and only during the hours when exhaust steam is available. A great majority of industrial plants operate from 44 to 54 hours a week and have exhaust steam available for heating only during these working hours, so that a considerable proportion of the heating which is required for any such establishment must be done with steam taken directly from the boilers regardless of whether there be privately generated power.

If an inside temperature of 70 deg. F. is assumed during working hours, say from 7 a.m. to 6 p.m. from Monday to Friday, and from 7 a.m. to 12 on Saturday and a lower temperature averaging, say 60 deg., is assumed for the remaining hours, 43 per cent of the total heating requirements occur during the working hours and 57 per cent during the night and Sunday hours. Even this figure of 43 per cent of the heating during working hours is a maximum seldom attained in actual operation. If the temperature is allowed to drop during the non-working hours, it must be brought up again before the working hours start, which involves a large expenditure of steam in the morning before there is any exhaust available. Probably a percentage that is more nearly the truth can be arrived at by assuming that a constant temperature is maintained during all the time and in this case a maximum of only 35 per cent of the heating will be taken care of by exhaust steam.

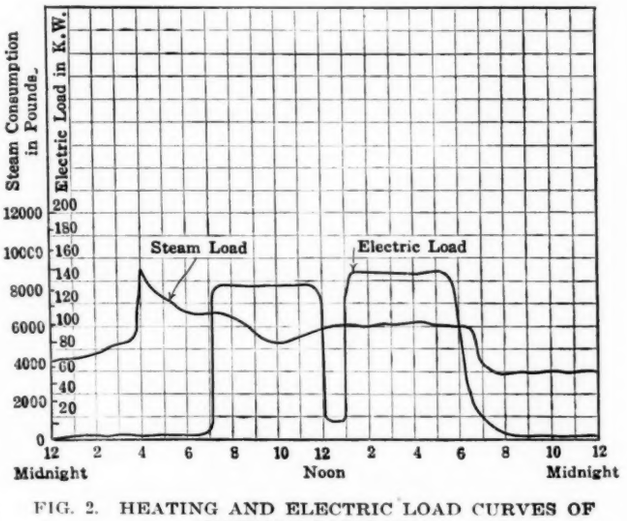


FIG. 2. HEATING AND ELECTRIC LOAD CURVES OF FACTORY BUILDING

Note that the peak of the heating demand comes in the early morning, whereas the electric load peaks come when the steam demand is low.

*Rochester Gas & Electric Corporation.

That the heating load is radically different in character from the electric load is well illustrated by Fig. 2. This curve represents the operation of a factory building where both steam for heating and electricity for power are purchased and the curves are plotted from meter readings. The scales are chosen so that the kilowatt curve may be taken to mean pounds of exhaust steam available for heating. Note that the heaviest heating peak occurs at 4 a.m. If heating steam and electrical

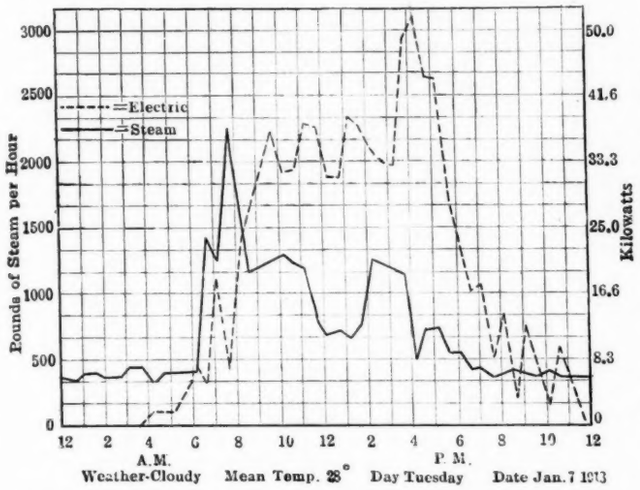


FIG. 3. HEATING AND ELECTRIC LOAD CURVES OF AN OFFICE BUILDING

energy were produced in a private plant instead of purchased outside, the exhaust steam would be in excess of the heating requirements during the day hours, and 27 per cent would have to be wasted. Moreover, the night heating and heavy morning peak would have to be supplied directly from the boilers, an amount equal to 50 per cent of the total heating requirements being necessary for this purpose. Thus, with a private plant, only 73 per cent of the exhaust steam could be used for heating, and as much again would have to be supplied directly from the boiler. Fig. 3[1] shows the steam and electric requirements of an office building, and illustrates the wide difference in the character of the steam and electric requirements.

Effect of Daily Temperature Variations

Up to this time we have been dealing with average temperatures. This leaves out of consideration one important factor that has a decided bearing upon the value of exhaust steam for heating; namely, the daily and hourly variations in outside temperatures. This seriously decreases the efficiency of operation of a steam-generating plant furnishing exhaust for heating.

Fig. 4 is a typical curve showing daily mean temperatures for a winter month. If the line *I* drawn at 70 deg. F. represents an inside temperature to be maintained, then the distance between the outside temperature *T* and *I* is proportional to the rate at which the steam must be supplied at any time. The area included between *I* and *T* represents the amount of steam required to maintain the assumed inside temperature. If we assume that there will be sufficient exhaust steam to take care of average conditions during this month and draw the line *E* at the temperature at which the exhaust available will just supply the steam needed for heating, then the shaded area above *E* represents exhaust steam in excess of heating requirements and the shaded area below *E* represents heating requirements for which there is no exhaust available. What we are particularly interested in is the amount of exhaust steam that is wasted.

In order to make the application of the temperature curve practical, it should be plotted in the form of a duration curve, as shown in Fig. 5. Here are shown the temperature curve, dotted, and the duration curve derived therefrom. The latter is plotted from the temperature curve by determining during how many days each temperature or a higher one prevailed, and plotting the values so derived. For example, point *M* means that for 18 days of the month the temperature was 32 deg. or above. The lines *I* and *E* are the same as in Fig. 4. Area *A*, Fig. 5, is the sum of areas *A*, Fig. 4, and area *B*, Fig. 5, is the sum of areas *B*, Fig. 4.

In the practical application of the temperature duration curve, it is convenient to plot a curve covering the whole heating season. The curve of Fig. 6 is a modified form of duration curve, plotted for Rochester, New York. It is the average of the duration curves for the heating seasons, Oct. 1 to May 31, of six different years, and was obtained by plotting as ordinates, not the actual external temperature, but the difference between the internal and external temperatures; that is, the difference between curves *I* and *T*, Fig. 5. These ordinates are proportional to the demand for steam heating, and

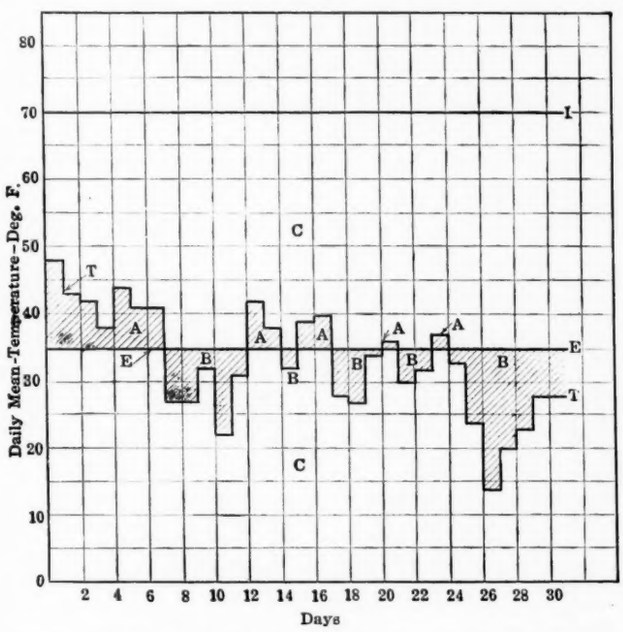


FIG. 4. DAILY MEAN-TEMPERATURE CURVE FOR DECEMBER FOR A CITY IN CENTRAL NEW YORK

Line *I* gives the inside temperature, *T* the daily mean outside temperature, and *E* the temperature at which the exhaust steam will exactly supply the heating demand.

the area beneath represents the total steam required for heating.

The first step in the application of this curve is to evaluate the ordinates in terms of steam demand for heating—in other words, to determine the pounds of steam required for heating per degree difference in temperature between the inside and the outside of the building under consideration.

The method of doing this will be described, but for the moment let us assume that this has been done in

[1] This curve is one of a series published in the N. E. L. A. Proceedings, Commercial Section for 1913.

some particular case and that the exhaust steam available during working hours will take care of a temperature difference of 35 deg. The rectangular area under the horizontal line *E* drawn at 35 deg. represents the total exhaust steam supplied during working hours. The shaded area *A* represents exhaust steam not needed for heating and therefore exhausted to the atmosphere. The shaded area *B* represents the amount of live steam that must be added to supplement the exhaust when the heating demand exceeds the available exhaust.

By assuming various inside temperatures and a series of values for the outside temperature at which the exhaust steam will just supply the heating load, and integrating the corresponding areas representing the live steam consumed and the exhaust steam wasted, the curves in Fig. 7 have been derived. From these curves the percentage of exhaust steam wasted and of live steam added may be obtained directly. The ordinates represent the outdoor temperatures at which the exhaust will just supply the heating requirements. For example, if this temperature be 35 deg. with an inside temperature of 70 deg., 21 per cent of the exhaust steam will be wasted and 14 per cent of the day heating must be supplied as live steam. It should be carefully noted that the percentages apply to the heating requirements during the hours when the building is occupied and not to the total heating requirements.

There are two ways by which heat is lost from a building. One is by transmission through the walls, windows, roof, etc., and the other is by the escape of

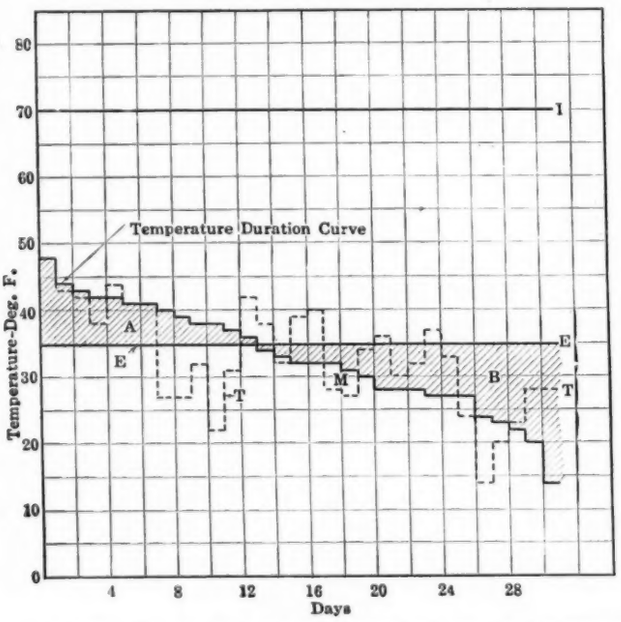


FIG. 5. TEMPERATURE DURATION CURVE FOR DECEMBER PLOTTED FROM THE CURVE IN FIG. 4

The dotted curve is that in Fig. 4 reproduced. Lines *I* and *E* have the same meaning as in Fig. 4.

the heated air contained in the building. The amount of heat transmitted through the walls, windows, etc., of a building is directly proportional, for all practical purposes, to the difference in temperature existing between the two sides thereof. The amount of this loss through the different materials ordinarily used in building construction has been pretty definitely determined and is usually expressed in terms of British thermal units of heat transmitted per hour per square foot of exposed surface per degree difference in temperature. These data may be found in all handbooks dealing with this subject of heating.

The heat loss due to the escape of air is also directly proportional to the temperature difference existing between the inside and the outside. For every cubic foot of air at building temperature that passes out, by whatever means, a cubic foot of outside air must come in and this must be raised to the inside temperature.

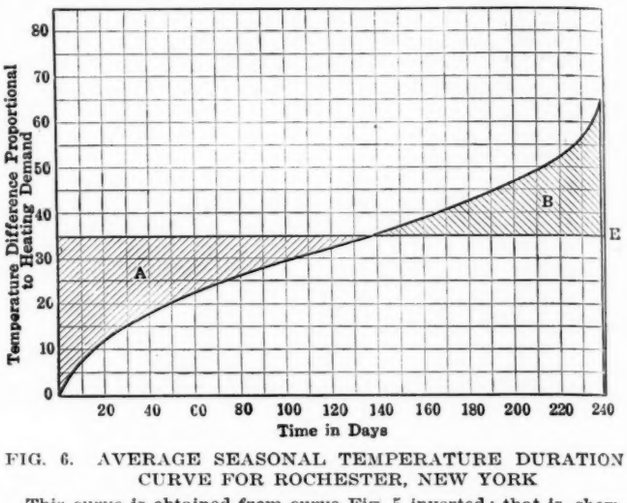


FIG. 6. AVERAGE SEASONAL TEMPERATURE DURATION CURVE FOR ROCHESTER, NEW YORK

This curve is obtained from curve Fig. 5 inverted; that is, showing temperature difference between inside and outside instead of actual outside temperature. It is the average of the duration curves for six consecutive heating seasons.

Where no particular provisions are made for introducing fresh air into a building, natural leakage being depended upon for ventilation, it is usual in heating calculations to allow for one complete change of air per hour if the building is of good construction and the windows reasonably tight. For buildings of poor construction this allowance may be as high as two or more, and for buildings of exceptionally good construction it may be as low as one-half. When mechanical ventilation is used, the number of air changes per hour can be calculated from the amount of air delivered by the fans.

It requires 0.018 B.t.u. to raise the temperature of one cubic foot of air one degree; so the volume of the building expressed in cubic feet multiplied by 0.018 gives the heat loss for one degree difference in temperature for one change of air per hour. For a greater or lesser number of changes of air per hour, the constant is modified in direct proportion.

The first step in the calculation is to determine the area of the exposed walls, windows, roof, etc. Where there is variation in the materials used or in the thickness, these should be listed separately. These areas multiplied by the proper constants, added to the heat loss due to air change, will give, when summed up, heat units lost from the building for each degree difference in temperature between the inside and the outside.

Experience has shown that, to the heat losses thus calculated, certain additions must be made:

Add 10 per cent whenever the distance between the floor and ceiling is over 13 ft. Add 20 per cent to the heat loss from the two sides of the building that are exposed to the prevailing winds—usually north and west.

The figure thus obtained for the total heat loss for one degree difference in temperature may be called the building constant. In order to determine the amount of heat that must be supplied during the heating season,

it is merely necessary to multiply this constant by the number of hours in the heating season and the average difference in temperature between the inside and the outside of the building. This product expressed in heat units may readily be converted to pounds of steam, tons of coal or any other desired unit.

While this gives the cost of heating the building, it does not, as a rule, give sufficient information for an

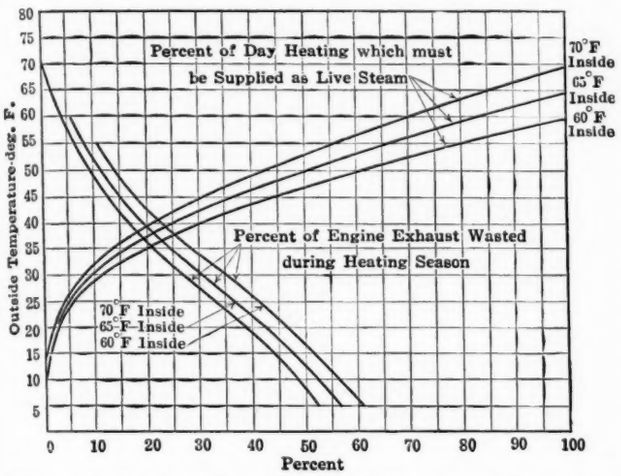


FIG. 7. CURVES SHOWING LIVE STEAM REQUIRED AND EXHAUST STEAM WASTED, IN PER CENT OF DAY HEATING FOR VARIOUS OUTSIDE TEMPERATURES

analysis of the relation between the cost of operating an isolated steam plant and the cost of purchasing power. A complete analysis involves distinguishing between the hours during which the building is occupied and those hours when it is not in use, at which time it is quite usual to carry a lower inside temperature. It is necessary also to distinguish between the hours during which an isolated plant might be supplying exhaust steam for heating and those during which steam must be furnished directly from the boilers.

For outside temperatures the normal temperature for each month may be obtained from the nearest United States Weather Bureau Station. The factors enumerated are constant for any given locality and for any given set of conditions and having once been worked out, may be tabulated so that, after the building constant is determined, the desired information may be easily and quickly obtained.

Means of Gaging Heating Performance Necessary

There are two divisions to this problem, the human and the mechanical. No matter how perfect a heating plant may be, results cannot be obtained without the co-operation of the fireman. On the other hand, a man cannot be expected to put forth efforts for efficient operation unless he has co-operation from the owner to the extent of being furnished such apparatus and materials as are required. It is fundamental that some standard must be provided by which the operation may be gaged. The main difficulty in doing this is presented by the constantly varying conditions of the weather, both as to wind and temperature. It would be simple to set up a standard of, say, so many pounds of coal consumed per 24 hours for heating, if the outside temperature and wind conditions were always the same. Then the effect of any changes either in equipment or operation could be immediately noted.

A long step in the right direction can be taken by plotting a curve between outside temperature and pounds of coal or pounds of steam required for heating. While such a curve cannot be expected to be exact, since the temperature is not the only factor affecting the heating requirements, it is the main factor and actual results will follow such a curve quite closely. Fig. 8 is plotted in terms of pounds of coal in 24 hours for a building whose heating requirements have been calculated. The curve is based on the assumption of 24-hour heating at 70 deg. F., an assumed furnace and boiler efficiency of 65 per cent and coal with a heating value of 12,500 B.t.u. per pound as fired. Numerous refinements will suggest themselves and may be applied as conditions warrant. For example, separate curves may be drawn for the day and night consumptions with different inside temperatures assumed.

It is evident that if this plan is to be carried out, there must be, as a minimum, some means of measuring the coal and a thermometer for determining outside temperature. In addition, there should be some means of measuring the total boiler feed when heating is done by steam, as is usually the case. On many heating systems, it will be possible to install a condensation meter on the returns, which, together with a cold-water meter on the makeup water line, will give the data desired. This information is essential for distinguishing between

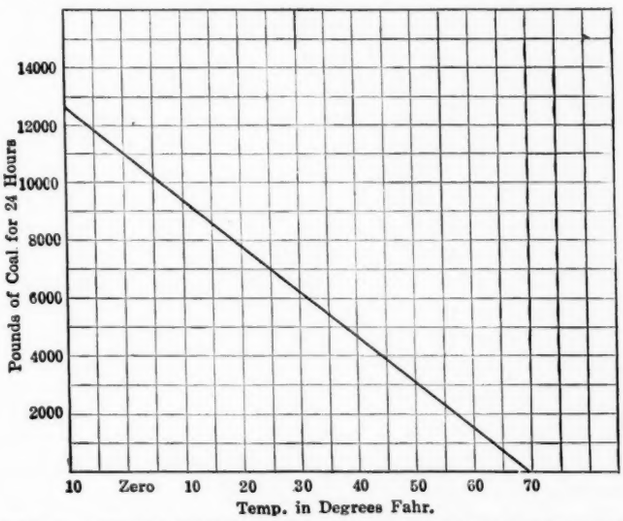


FIG. 8. CURVE SHOWING COAL REQUIRED FOR HEATING FOR DIFFERENT OUTSIDE TEMPERATURES

This curve is useful for checking the daily performance of the heating plant.

the performance of the boiler itself and the operation of the heating system.

A great deal of fuel is wasted by carrying buildings at unnecessarily high temperatures. This usually results in the opening of windows, which merely increases the waste. In many places the night temperatures are carried too high. One or two recording thermometers placed where they will measure average conditions will aid greatly in checking such wastes. There is nothing new or startling about these suggestions. They amount to but little more than the application of common sense and a little attention. The results that can sometimes be accomplished are quite extraordinary. The writer knows of a large factory where a saving of more than 30 per cent in the steam used for heating was effected by giving a little attention to the operation at night and using some recording thermometers.

Something About Separators

By W. H. WAKEMAN

THREE modern high-speed engines were used to supply power for a certain manufacturing plant. They were removed and replaced by three turbines. The sole reason for the exchange was that all exhaust steam was wanted for use in the works, but inasmuch as the exhaust contained more or less cylinder oil on coming from the engines, the turbines were adopted, because they used no cylinder oil.

A dealer claims that he supplied one separator to another plant, with the expectation of furnishing more provided the first removed all cylinder oil from the exhaust steam and the others were delivered in due time. If it was possible to secure this result in one case, why could it not have been done in the other? Changing the prime movers was much more expensive than it would have been to install separators. If there was any difference in the steam consumption, it had no weight in arriving at a decision in this case, because all exhaust steam was used to advantage in manufacturing processes. Several other dealers in separators claim to secure practically the same results. Why are failures along this line frequently found?

One reason is because some cylinder oils are much more viscous than others. As this quality may be defined as "sticky," it means that some kinds excel others in cleaving to the iron surface with which they come in contact, hence if a certain separator does not remove all the oil, a simple and inexpensive experiment may be tried by substituting other brands of oil until better results are secured or the separator is proved to be responsible for the failure.

The chief engineer of a mill found that the exhaust steam from his engine contained oil. The separator was located next to the engine and beyond it, a feed water heater. When the location of these two appliances was changed to that illustrated in Fig. 1 (page 763), the cylinder oil was removed from the exhaust steam, and this was the only change made. The philosophy of the operation and succeeding practice is that when cold water was pumped into the heater and a portion of the steam condensed in the process of heating the water, the resulting drops of water combined with the particles of oil, and as the mixture became heavier than the steam, it was readily separated from it by centrifugal force; hence, the better results secured.

Separators should be placed as their makers intended that they should be. A good illustration of this necessity is shown in the following. Steam should pass upward through Fig. 2 and downward through Fig. 3. If the direction of flow in either case is reversed, the best results cannot be expected. Where this design of separator is ordered direct from the manufacturers and working conditions are specified, they will be sent accordingly, but as time passes and changes in the piping are made, they may be put out of service. Later on, when required for other places, they may be installed so that the direction of flow is not the same as formerly. This is more likely to happen because the castings are practically the same, but that does not prove that they are interchangeable.

Fig. 4 illustrates a separator that should be located as shown, with steam passing upward through it. Fig. 5 shows a design that is not so likely to be mistaken as some other types. The curved deflecting plates must perform the separating function when the steam first enters the separator, and the reservoir must be located at the lower point; hence, steam flows downward and the oil and water go out through a suitable drip pipe.

If steam and oil pass upward through the type of separator shown in Fig. 6, some of the oil will be taken out, but the results will be more satisfactory if the direction of flow is downward.

Fig. 7 shows a horizontal separator with the inlet at the right and the outlet at the left. Fig. 8 shows a similar device, but the direction of flow is from left to right hand. If good results are desired, these directions of flow must be followed, but if it is necessary to use either one for a direction of flow that is opposite to the illustrations, it may be done by turning the separator around. In this respect a horizontal differs from a vertical separator, as the former can be reversed at pleasure to meet the direction of flow. However, care should always be taken to have the steam enter as the makers intended.

Fig. 9 is designed for steam flowing in either direction, and it does not make any difference which way it is connected.

British Views on Fuel-Oil Installations

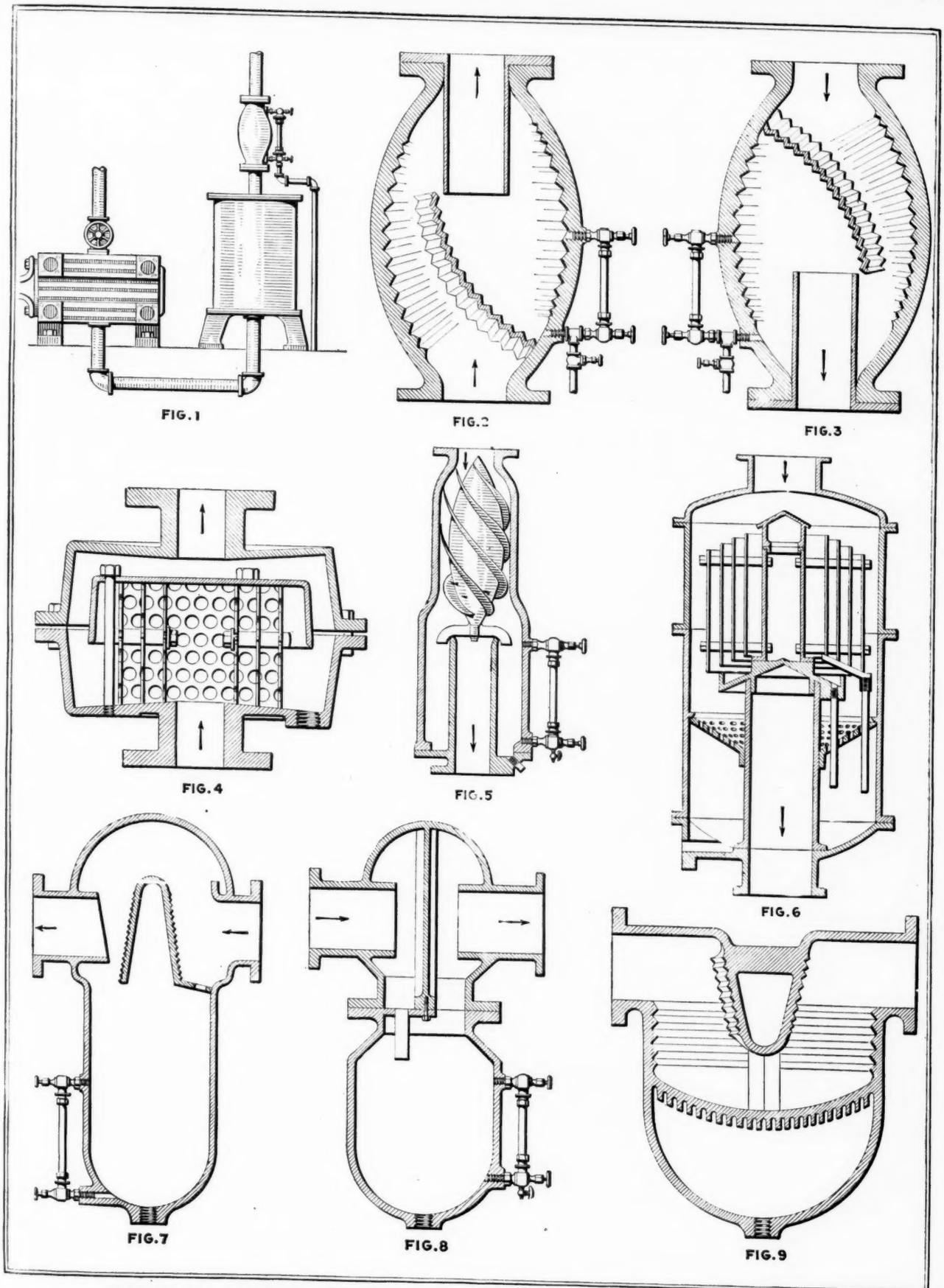
The mechanical and economic questions involved in the use of fuel oil are receiving the same serious consideration in England as in the United States. During the recent British coal strike C. E. Stromeyer, chief engineer of the Manchester (England) Steam Users' Association, investigated a number of oil-burning installations and submitted his findings to the association in an eleven-page report. The following information abstracted from this report may be of interest.

The types of apparatus in use may be classified as: (a) The pressure-jet system (b) the steam-jet system and (c) the air-jet system. In the pressure-jet system the oil is atomized by pumping it under pressure through specially formed burners from which it issues with a whirling motion at high velocity. The atomizing is generally better than in the steam or air-jet systems, and combustion may be almost perfect in this type, but the installation, involving a pumping set and special furnace fronts, etc., is considerably more costly.

The air-jet system is little used in power plants because the provision of a compressed-air supply is less convenient and generally more costly than steam, while the system is less efficient than the pressure jet system.

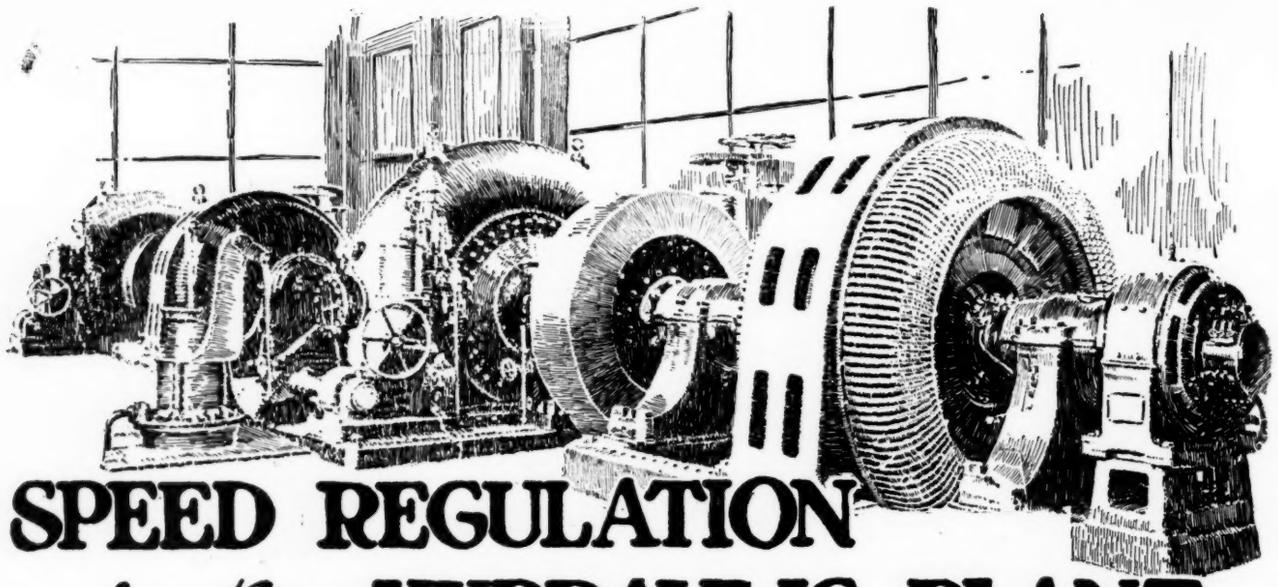
The sudden cooling of boilers and brickwork should be avoided. Silica firebrick, in particular, is resistant to high temperatures, but is likely to crack if cooled suddenly. Hence, when shutting down a boiler having silica brickwork, it is necessary to keep the air-admission openings closed and allow the brickwork to cool gradually.

Regulation of boiler duty should be effected by adjusting the flow of oil and the air admission. For good results there should be a light-gray smoke at the chimney top. Absence of smoke usually means inefficiency through too much air, while dense black or yellow smoke means too little air or bad atomizing of the oil.



FIGS. 1 TO 9. SHOWING SEVERAL DESIGNS OF OIL SEPARATORS IN SECTIONAL VIEWS

Fig. 1—Separator placed above the heater gave better results than when placed next to the engine. Fig. 2—Steam enters at the bottom of the separator. Fig. 3—Same type of separator design with steam entering at the top. Fig. 4—Another separator in which the steam should pass upward. Fig. 5—Steam flow is downward. Fig. 6—Steam can flow in either direction. Fig. 7—Horizontal separator, steam entering at the right. Fig. 8—Separator with inlet connection at the left. Fig. 9—Steam can flow in either direction.



SPEED REGULATION *in the* HYDRAULIC PLANT

*By N. L. Devendorf**

Conditions that must be met by the waterwheel governor. Development from the early flyball governor to the present oil-pressure type. Requirements of low-head versus high-head plants. Operating in parallel.

THERE are three characteristics of the steam-driven prime mover which have an important bearing on its speed regulation under conditions of variable load: First, the valves and valve gear are light and well lubricated and their position may be changed instantly; second, steam is highly elastic, is in a highly compressed state, and mobile, so that it enters the engine or turbine at a high velocity and begins its work immediately; third, steam is light and possesses little inertia in proportion to the power it develops, so that its velocity in the pipes and passages may be changed instantly without alteration of the effective pressure acting on the piston or blades.

Power Required to Set Mechanism in Motion

In the hydraulic turbine and the flumes and passages connected with it the conditions are quite the opposite. Here are heavy, massive gates and gate rigging, operated by heavy shafting, rods and gears, with corroded, gritty bearings under water, so considerable power is required to set the mechanism in motion. The water column is non-elastic and incompressible and enters the passages of the turbine at a low velocity as compared with that of steam. The water is heavy and possesses considerable inertia, so that a change in its velocity brings about a change in the pressure at the turbine blades.

With a given gate opening the turbine will develop a certain amount of power on the shaft. As long as the gate opening and head remain constant, this amount of power will be turned out by the turbine. If additional load comes on, there is no additional energy to take care of it, and some of the energy is taken from the load already being carried, to supply the new demand, with the result that the turbine carries the entire load at slower speed. On the other hand, if load is taken off, there is surplus energy that must find an outlet, and the only outlet available is its absorption through an increase of speed on the remaining load.

With alternating current the speed of the generator controls the frequency, and this in turn determines the speed of the motors driving the industrial load. The electrical system of generation, transformation, transmission and distribution may be considered as a rigid coupling between the prime mover and the distant loom or lathe or other machine, and the speed of the driven machine will vary as the speed of the prime mover fifty or a hundred or two hundred miles away.

Adjustment of Gates for Change in Load

If normal, constant speed is to be maintained, there must be an adjustment of the turbine gates for every change in load. In some of the smaller industrial installations where the process is steady and continuous throughout the day, these adjustments may be made by hand with fairly satisfactory results, by giving the plant close attention when the load is coming on or going off, but for the ordinary mixed load of industrial, commercial, domestic and railway service, hand control would be out of the question. Among the earlier experiences of the writer was an attempt to operate a small railway plant on hand control. This installation was operated in parallel with a larger plant during the day, but at night the last two or three cars were brought in with it. When the larger plant was shut down, the "man at the wheel" was exceedingly busy for an hour or two, and in spite of his best effort the regulation could scarcely have been worse. Better success was had in two lighting plants

*Instruction Department, Consumers Power Company.

later operated with manual control, but as the motor load came on it was necessary to have some means of holding the speed as closely as possible to normal in spite of sudden and often severe fluctuations of the load.

One of the earlier forms of waterwheel governor consisted essentially of a heavy pair of flyballs and

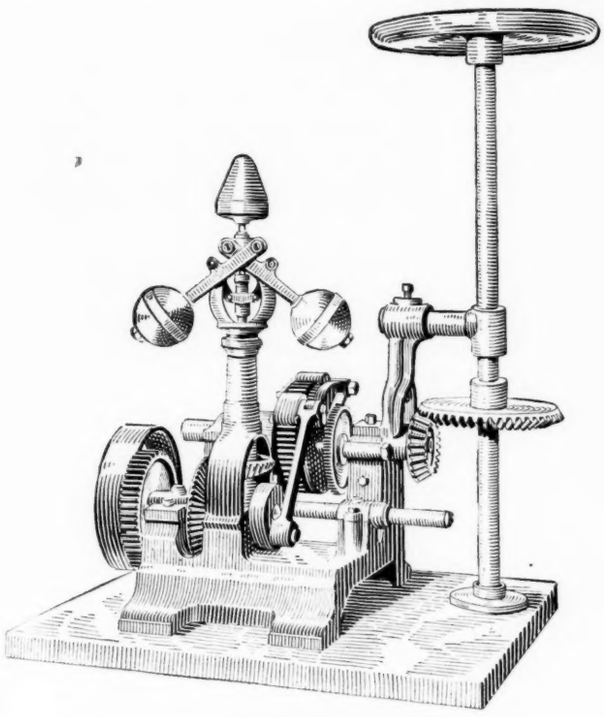


FIG. 1. SNOW WATERWHEEL GOVERNOR

two opposed ratchet wheels and pawls, the pawls being oscillated back and forth close to the ratchets of which Fig. 1 is a type. The vertical motion of the flyballs was imparted directly to one or the other of the pawls, and the gates ratcheted slowly in the open or closed direction. In another early form the action of the flyballs closed an electric circuit to one of two magnetic clutches which were belt-driven in opposite directions and, when energized, engaged the gate rigging. Various ingenious devices of this nature were developed, but in all governors where the motion of the gates was controlled by the flyballs, a serious obstacle to satisfactory regulation was found in the tendency of the governor to "hunt" or "race."

Sluggish Action of Governors

The inertia of the water column and the pressure changes brought about in it by a change in velocity do not permit the speed to change at once. By the time it does change sufficiently to bring the flyballs back to the neutral point and stop the motion of the governor and gates, the gate movement has been too great for the change in load, and the speed will overshoot the mark, causing the governor to act in the opposite direction. This may be kept up for a number of strokes on a single change in load, but if there are several variations in succession, the condition may become so bad that safe and efficient operation is out of the question.

As the need for a better governor developed with the growth of electrical service, the oil-pressure type appeared, and it is this type that has stood the test of time and experience and has been developed into the powerful, accurate mechanism found in the modern hydro-electric plant.

An oil-pressure governor consists essentially of one, or in the larger units two, power cylinders or servomotors with the necessary mechanism to connect them to the gate rigging of the turbine, a main or relay valve through which oil under air pressure is supplied to the power cylinder, a pilot valve which operates the relay valve, and which is in turn operated by a sensitive flyball governor head and an anti-racing mechanism that overcomes the difficulty experienced with the older types from oscillating the speed above and below normal while making a change in load.

Energy for Actuating Governor

Energy for actuating the governor is stored by pumping oil into a closed tank against a cushion of air, which is thereby compressed to 100 or 200 lb. pressure. In the earlier development of this type of governor the exhaust oil was discharged into a vacuum, but this has been found to cause serious breakdown of the oil, filling the piping and passages with sediment and rendering the governor sluggish or inoperative. Such conditions made necessary a periodical dismantling of the machine for cleaning, so in the more recent designs the oil is discharged to atmosphere in an open tank, from which, after filtering, it is pumped into the pressure tank. By this method the life of the oil is increased and the cost of maintenance is therefore decreased.

An essential part of the modern governor is the

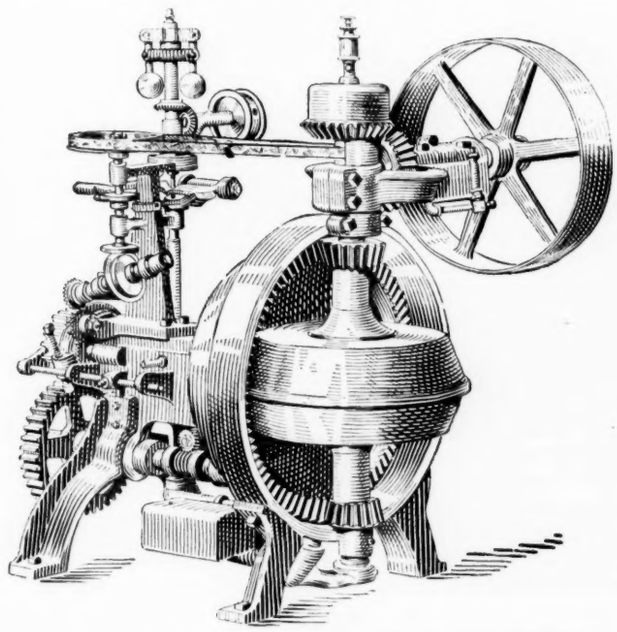


FIG. 2. WOODWARD WATERWHEEL GOVERNOR

anti-racing or compensating mechanism. The mechanism consists essentially of a connection from the pilot-valve stem to the gate mechanism, so that as soon as the gates begin to move, the pilot valve is brought to its center, stopping the movement of the gates some time before the speed has become normal and the flyballs have come to their neutral position. In one

successful form of governor the pilot valve stem is shortened or lengthened by this device irrespective of the position of the flyballs, by a rack turning the right-and-left threaded sleeve on the stem. The details differ somewhat in different makes and different types of the same make, but the principle is the same. The

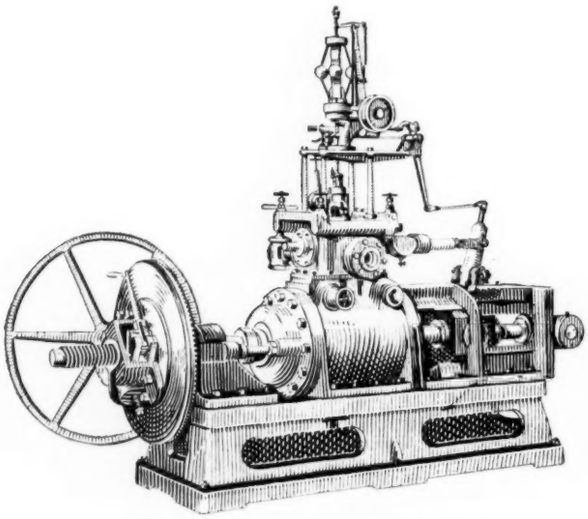


FIG. 3. ONE DESIGN OF LOMBARD GOVERNOR

pilot valve is centered and the motion of the turbine gates stopped before the speed has returned to normal.

The connection from the gate rigging to the pilot valve is not rigid, but is made through a dashpot, which is one of the important parts of the device. The dashpot pushes the rack over, shortening or lengthening the valve stem against the tension of a spring, and as the speed change becomes settled, slowly comes back again, so the valve is ready for another variation. The dashpot is capable of fine adjustment, and when properly adjusted, the governor is as nearly dead beat as is possible in a hydraulic-turbine installation.

It is not the intention to describe the various types and makes of governor on the market. The makers of these machines furnish detailed descriptions and instructions to those having the handling of their product in which everything is covered completely.

Balancing the Speed of Gate Action

In speed regulation in the hydraulic plant the problem is not so much in getting a governor that will move the heavy gates, for that is a simple mechanical problem, but in so balancing the speed of gate action with the effect of the velocity and pressure changes in the water column, and making the complete gate movement just sufficient to take care of the load changes and restore normal speed, so that close regulation, with a minimum of disturbance and strain in the water passages, will be obtained.

In the low-head open-flume setting the problem of velocity and pressure is at a minimum, and the governors may be adjusted to act as quickly as may be necessary for the closeness and magnitude of regulation called for. As the head and the volume and inertia of the water column increase, the action of the gates would be slower, to avoid too abrupt changes in the velocity and pressure in the penstock, until a point is reached where it is not safe to alter the velocity of the water column, except by slow degrees and by hand. With these high heads regulation is obtained by deflection of the water jet on or off the buckets of the impulse turbine or by use of a duplicate of the power nozzle as a relief, opening the one and closing the other simultaneously by governor action and closing the relief slowly in case of light load.

Operating Plant in Parallel

Where a plant is operated in parallel with other plants through a transmission line or distribution system, the speed regulation takes on a new aspect. If several plants of approximately the same capacity are working in parallel, speed regulation means largely load regulation, the load being divided between the plants according to stream flow and other conditions that properly come under the head of operation and dispatching. Sometimes one plant of a group is adjusted for close regulation, the other plants carrying a steady load, their governors being set for sluggish action under normal conditions, but in the event of a radical change in system frequency they act to hold the speed at normal value.

This setting for steady load or close regulation is accomplished by alteration of the length of the pilot-valve stem, so that the regulating machines tend to revolve a trifle faster than the others. They will in this case pick up or drop load before the other governors begin to act.

When it is desired to "back out" of load, the valve stem is shortened until the gates begin to close. When

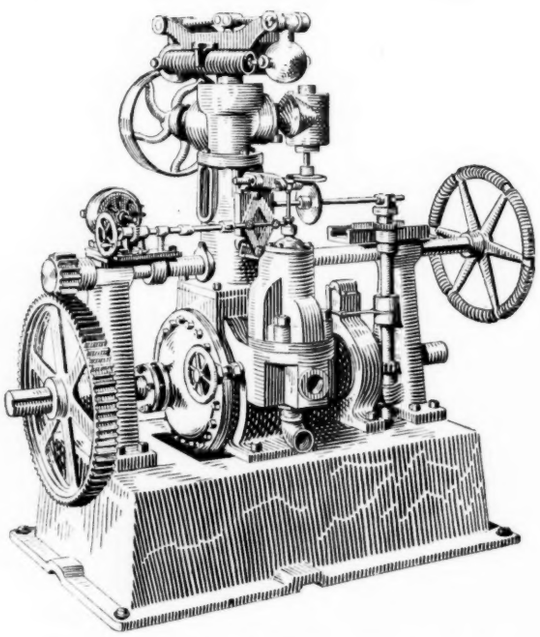


FIG. 4. HOLYOKE WATERWHEEL GOVERNOR

it is desired to pick up load, the stem is lengthened until the gates begin to open. These operations are independent of the flyballs and do not affect their operation. The valve stem is lengthened or shortened, thus raising or lowering the valve, by means of a right-and-left threaded sleeve on the stem, a different one from that used in connection with the anti-racing mechanism. This is turned by hand or by means of a small motor controlled from the switchboard, the latter being the more desirable method.

Where the hydro-electric plant is operated in parallel with steam plants, its regulating problem is reduced to a minimum. It is desirable, except in case of high water, when the plant is spilling, to operate the turbines at or near their point of most efficient gate opening. This makes it necessary to carry a steady load, according to the stream flow, on the water plant and let the steam plants take care of the fluctuations. But even if the governors do not move twice in a day, they must be kept in such condition that they will act instantly in case of loss of load or other sudden variation by reason of transmission-line trouble or otherwise.

A turbine that is required to regulate continuously will show a higher maintenance cost than one that is operated on constant load. The gates and gate rigging, especially that which is submerged, will wear out and require renewal, and the cost will be not only for labor and material, but for loss of service as well, if owing to needed repairs it is necessary to spill water when a machine is down.

With increasing distances of transmission, interconnection of steam and water plants, and the inevitable

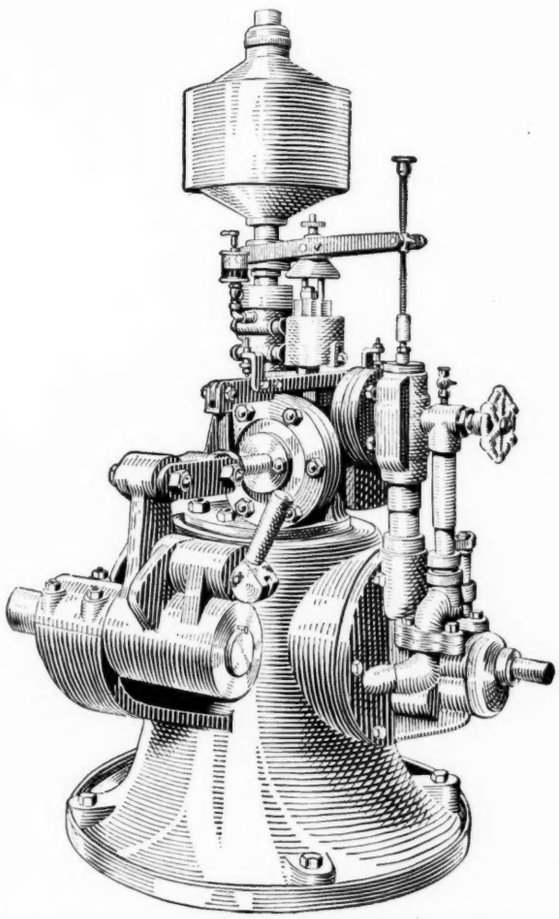


FIG. 5. ONE TYPE OF PELTON GOVERNOR

smoothing out of the load curve by the greater amount and variety of load carried, together with the continued steady improvement in the design and detail of the governors, the problem of speed regulation is being much more satisfactorily handled than it was in the earlier days of the writer's experience, and with the modern governor properly adjusted, good service can be had in the isolated community that depends upon a single plant or even upon a single small unit in a plant.

The development of water-turbine governors makes an interesting study, and the advancement in their design has been such that close regulation of the generating units is obtained, as is shown by the operation of several units in parallel not only in a single plant, but in plants that are tied in together.

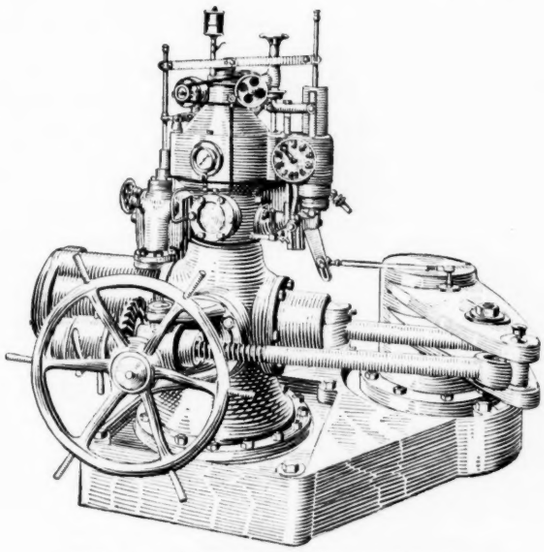


FIG. 6. ALLIS-CHALMERS GOVERNOR

Interpreting Boiler-House Meter Readings

BY W. A. DARTER

It is essential that a power plant be equipped with indicating and recording instruments, and the better the readings are interpreted, the more efficient the plan can be made. The engineer is the first one to make use of these readings, and it is up to him to know how to interpret them.

Fuel-weight records are necessary for calculating the cost of production and estimating the efficiency of a plant. They show the operating efficiency between the shifts and make it possible to determine the most efficient method of operating the plant. Weight records also show the loss between fuel bought and fuel burned under the boilers.

Feed-water thermometer readings give an insight of the amount of fuel saved or lost from any one fixed temperature. In an open feed-water heater feed-water-pump trouble can sometimes be determined by high-temperature feed-water. The feed-water temperature chart shows what the possibilities are toward making greater savings. It will also show what portion of the day and under what loads the heat balance is unstable.

A boiler gage glass, if in order, indicates at a glance the water level in the boiler and is a guide to safety. Low water indicates danger of burning a boiler. High-water level suggests a priming-boiler, which may wreck an engine cylinder or rapidly wear away turbine blades. The water glass indicates the amount of water blown down in a boiler and also aids an engineer in keeping a proper high-water level just before a peak load comes on. When the load drops off suddenly, the gage glass

will show how much feed-water can be pumped into the boiler to take up excess heat, and save steam from being blown out through the safety valve.

A steam-pressure gage indicates the pressure inside the boiler. A low pressure indicates either an increased steam load or a low fire. High pressure indicates a decreasing steam load or excess fire. High steam pressure is a reminder to the firemen either to decrease his fires, or, if this cannot be done fast enough, to pump in feed water to take up excess heat. A steam-pressure chart will show an engineer how steady the steam pressure has been kept, which is an aid to higher efficiency. The chart will also indicate the number of times the safety valve has popped during a shift or day. If both pressure and indicating gages are used, each can be checked by the other and greater safety is assured.

The steam-flow meter indicates the amount of steam a boiler is producing and the per cent load carried by the boiler. A low reading indicates that it is time to cut out excess boilers. High readings indicate it is time to put in another boiler. The readings of a flow meter are an index of the amount of water that should be entering the boiler. Low readings on one boiler and high readings on another show the conditions of the fires and indicate low boiler efficiency. Steam-flow-meter charts give accurate data for calculating the amount of water evaporated by a given amount of fuel.

Feed-water meters are necessary in order to estimate the boiler efficiency. A record of each shift will help point out the most efficient shift and the weak points in operation.

Readings of draft gages should be given consideration. The draft gage indicates the gas pressure in the several parts of the gas passages of the boiler, and the firemen can determine by comparing similar conditions, when the boiler becomes choked by soot or ashes, also when baffles are in good or bad condition and when the coal fires are choked or full of air-holes. If the boiler becomes dirty from soot and ashes, the reading of the draft gage at the damper and over the fires will become farther apart. If the baffles become bad and gas is bypassed, the reading of the the two gages will become nearer together. If the fires become choked the gages will read closer together and higher, and if the fires become full of holes the two gages will read farther apart and each will read lower. When both gages read extremely low and their readings are farther apart than normal, they indicate that the baffles are in bad condition and the fires are shallow or full of holes. When both gages read extremely high and their difference is normal, the boiler is choked and the fire bed is choked.

Pyrometer readings indicate the temperature of the combustion chamber. The hotter the fire the higher will be the efficiency of the boilers. The temperature of the fire bed, however, cannot be carried beyond a certain limit, because of the rapid deterioration of the boiler lining and setting. The pyrometer becomes a guide to good combustion and indicates the amount of excess air necessary to keep the temperature within the right range.

Flue-gas thermometer readings indicate the condition of the gas temperature passing from the boiler and are a guide to the heat losses that are greater than normal and that are carried up the chimney. With a given steam pressure and a given load on a boiler the flue-gas thermometer will indicate either of three conditions in the boiler gas passage or all three combined. First, an excess gas temperature may indicate boiler tubes covered with soot or ashes; second, it may indicate leaky baffles; and third, it may indicate scaly boiler tubes. The more soot collected on boiler tubes the less heat will be transferred to the water, hence more heat is lost up the chimney. The more gas bypassing the baffles the less heat will be absorbed from the gas. The more scale on the inside of the boiler the less heat will be absorbed by the water. With all three conditions existing at the same time, the flue-gas temperature will become excessive. Each temperature reading of the gas thermometer should be an index to the load carried on the boiler.

Readings of the steam thermometer indicate the superheat of the steam, and are a guide to higher efficiency. The steam should be superheated to the point where the difference in the increased saving in heat units and the loss in deterioration of piping and machinery is greatest.

An air-flow meter is sometimes used in connection with the steam-flow meter instead of the Co_2 meter. The air-flow meter makes it possible to save the waste due to excess air and is a guide to higher combustion efficiency. The flow of air should also be in the same proportion to the stoker speed.

Fuel-oil meter readings make it possible to check the fuel cost of production. They are a check against different operating shifts and serve as a guide to wasteful methods in the burning of oil. The coal-scale records serve in the same way and are essential to the efficient running of the plant.

The carbon-dioxide meter gives a record of the combustion of the fuel burned under a boiler. It tells the percentage of carbon dioxide in the burnt gases. Too high CO_2 will indicate not enough air for the highest efficiency; too low CO_2 readings indicate too much air used in combustion or bad air leaks in the boiler setting. The CO_2 record is a guide to good combustion and efficient operation.

Dean Cooley, new president of the Federated American Engineering Societies, says that the Federation has established itself in the respect of the public and that what must be done now is to put the proposition over to engineers themselves. This is strange, but largely true. The Federation has been given a good deal of publicity, and the newspapers now treat it with considerable repect; much of this has been due to the fame of the organization's first president, Herbert Hoover. But, however that may be, the Federation is well regarded by the public. Engineers, on the other hand, who should be its strongest boosters, to a certain extent remain skeptical. Too many of them are waiting to be shown, whereas it is up to them themselves to do the showing. It is well that the new president recognizes this fact, and it is to be hoped that engineers will meet him halfway in his efforts to interest them in what is potentially the greatest and most powerful engineering organization of all time.

The A. S. M. E. has announced that C. H. Berry and John H. Lawrence have been elected to the executive committee of the Power Division to take the place of Prof. W. B. Gregory and Thomas E. Murray, retired. These new members, together with A. D. Bailey, A. G. Christie and L. S. Marks, constitute the present executive committee of the division.

Power Plant Accounts—X. The "Income" and "Profit and Loss" Accounts

By WILFRED A. MILLER

THE isolated plant differs widely from the public-service company in that it is not operated for profit on its output. In both cases the efforts of the operating force are to keep the cost down to the minimum, but in the one case this results directly in a profit on the power generated, whereas in the other no benefit accrues to the power plant. It has been pointed out in previous articles that this condition of affairs can be remedied. There is no reason why the power plant, in a factory for instance, should not be treated as one of the manufacturing agencies and be accorded a profit on its output, if it has earned one.

However, as shown at that time, any profit allowed to the power plant must be set aside carefully and kept as a separate item until the product, in whose manufacture it has been used, is disposed of to customers of the concern. This procedure is required to eliminate any inflation in the value of the product before it is sold; it is necessary in order to prevent what are known as "anticipated" profits as distinguished from real profits received by the concern when goods are sold. The output of the central station is determined by the demand of its customers. It is selling its product to outsiders as quickly as it is producing it and hence is immediately entitled to show a profit for the sale, provided one has been earned. The case of the isolated plant supplying a factory with power is, however, quite different. The power it generates is consumed in producing other kinds of products and it may be days, or weeks, or even months before these products are finally disposed of to outsiders, and until that time the power plant may not collect its anticipated profit on the power that has gone into the product, although it may keep track of how much that profit should be when it is finally realized.

> This is the tenth of a series of articles written in conversational style and treating the subject of power-plant accounts in a thorough, yet simple manner. They were prepared primarily for the guidance of the operating engineer who wishes to keep track of the cost of the power he is making, but who knows nothing at all about bookkeeping. Others may find the articles helpful in clearing up their ideas on the subject. This installment starts by reviewing part of what has gone before, and then shows how to enter in the journal, and post to the ledger, the transactions involved in the sale of power to the other departments. Two new ledger accounts, "Income," and "Profit and Loss" are described, and their use is explained.

The foregoing facts and their underlying principles have already received considerable attention, so that this brief review of them will suffice as a preliminary to the details of the bookkeeping entailed by such a system of handling power-plant accounts.

The simplest case to assume is that in which the power output of the isolated plant is composed entirely of electrical energy. This will be still further simplified by supposing that the isolated plant is in direct competition with central-station service at low rates. Let us agree on an imaginary rate of 2.1c. per kw.-hr. for this purpose.

In order to determine how much profit we have made in a month, we must know two things—how much it has cost us to manufacture the power and how much we "sold" it for. For the former purpose we must have kept track of our costs during the month, and for the latter we must have an accurate record of our "sales." Our costs have all been entered in our books; in fact our excuse for keeping books has been to get at our cost of power generation. Our sales must be obtained from meters connected in the feeders which run to the various departments. Two things are requisite for the purpose—first, the meters themselves, and second, provision for a system by means of which the meters will be read regularly at the appointed time. Thus it will be seen that bookkeeping of itself will not do much toward determining profits unless supplemented by meters. This introduces an important phase of our cost work. Our books will serve to tell us how much it is costing us for power every month, but they will not tell us how much power has been generated. If our only concern were merely to find out how much the power expense amounts to each month, our books would be all that we should require. But is that all we wish to get out of our cost system? If it were, it would scarcely be necessary for us to go in for all the elaboration of expense items that has been indicated in earlier discussions. It would be sufficient merely to record all the items in some book, such as a journal, and to add these together at the end of the month to get the total for the period. The mere ascertaining of total cost, irrespective of any other factor, would be only a poor excuse for the installation of any but the crudest system of bookkeeping. The really important function of a properly developed system of cost accounting is to provide a measure of the efficiency of production with a sufficient amount of detail to indicate how improvements can be effected or where they have been accomplished.

To illustrate the points raised in the foregoing, let us take the case of a plant that is not equipped with meters. In March we find the total expenses amounted to $5,000, whereas in April they were only $3,000. From these figures we might be led to conclude that we had operated more economically in April than in March. This, however, might be a false conclusion. Thus, in March we might really have generated 250,000 kw.-hr. and in April 120,000 kw.-hr., only we had no means of knowing it because we had no meters to tell us. If the production had been of these amounts, then we would have for March $\frac{\$5{,}000}{250{,}000 \text{ kw.-hr.}} = \$0.02 = 2\text{c.}$ per kw.-hr., whereas for April the rate would be

$\frac{\$3,000}{120,000 \text{ kw.-hr.}} = \$0.025$ or $2\frac{1}{2}$c. per kw.-hr. Hence, although the total cost for April was $2,000 less than that for March, the cost per kilowatt-hour generated was $\frac{1}{2}$c. greater, showing that our efficiency was lower in April than in March. Without meters it would be impossible for us to ascertain such a condition; with them it would be the outstanding fact. It may therefore be said that an important part of our cost-accounting equipment consists of meters, and that if we are at present getting along without them, it is incumbent upon us to recommend that they be installed. When we speak of meters, don't let us think merely in terms of electric meters. Steam-flow meters are equally important. Neither should we forget water meters, nor any other metering device that may be required for special forms of power supply.

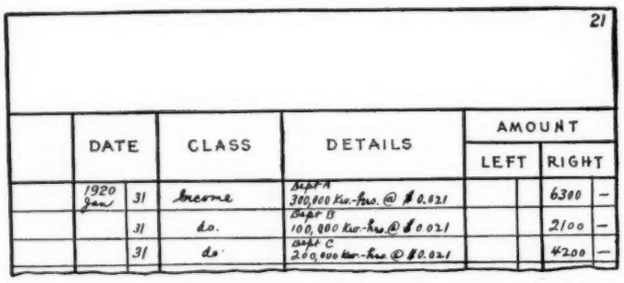


FIG. 1. JOURNAL ENTRIES OF INCOME FOR JANUARY

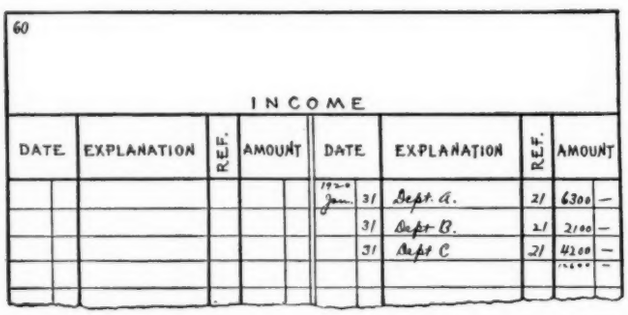


FIG. 2. ENTRIES OF FIG. 1 POSTED TO THE INCOME ACCOUNT

In order to proceed with the development of our system, we must make the assumption that we are equipped with the necessary meters. In our imaginary example we have limited our output to electrical energy, and we shall therefore be obliged to consider only electric meters in getting at our results, but it must be understood that such an assumption has been introduced only to illustrate a method and not to serve as a practical example.

To proceed with our illustration, let us suppose that we find the following to be facts at the end of the month:

POWER DELIVERED TO MANUFACTURING DEPARTMENTS

Dept.	Kw.-Hr.	Rate per Kw.-Hr.	Amount to Be Charged to Dept.
A	300,000	$0.021	$6,300
B	100,000	.021	2,100
C	200,000	.021	4,200
Total.....	600,000		$12,600

From the Total-Cost account in our ledger we find that the expenses for the month past total up to $12,000, indicating that the power plant had made an imaginary profit of $12,600 — $12,000 = $600 for the month.

We must now find out how we are to record these facts in our books. So far as the total cost is concerned, we do not have to go into any details, since we are already familiar with all the bookkeeping that has to be done to arrive at it. What we do have to discuss, however, is the method of handling the charges to the various departments and the profit made on those charges. For this purpose we go straight to our journal again. Let it be remembered that the journal is nothing more than a memorandum book in which we jot down all items of expense as they occur; and not only items of expense, but all others, such as investment and income.

As an example of the latter it will be remembered that we dealt with the possibility that our plant was situated in a locality where we could sell ashes instead of having to pay for their removal. That is, ash removal became a source of revenue instead of an expense. Our method of handling that situation was to enter the amount of such revenue items in the right-hand "amount" column of the journal instead of the left-hand one. Now when we charge Dept. A or Dept. B or any other department for power, we must make an entry of the fact somewhere, and since our journal is the book in which we make all memoranda concerned with the money matters of our business, it is perfectly natural that we should use it for the purpose of making a record of our charges to the various departments. Such an entry indicates that the department concerned owes us a certain sum for the power which we furnished to it. That is, it represents income even if not immediately paid. The principle involved is the same as that which we meet when we are dealing with bills rendered against us. Thus, if a concern of boilermakers sends us a bill for repairs made to one of our boilers, we enter the amount of the bill as an expense, even though we know that our company will not pay it for some weeks to come. So with our charges to the various manufacturing departments. The mere fact that they do not hand over money to us in settlement of

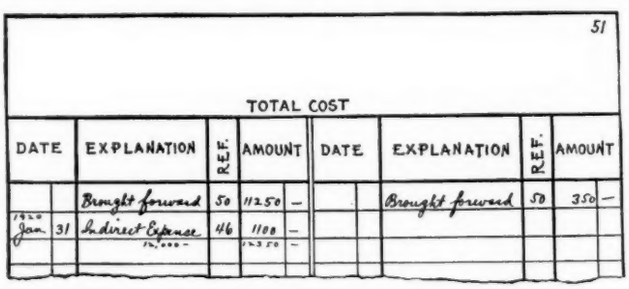


FIG. 3. FINAL JANUARY ENTRIES IN THE "TOTAL COST" ACCOUNT

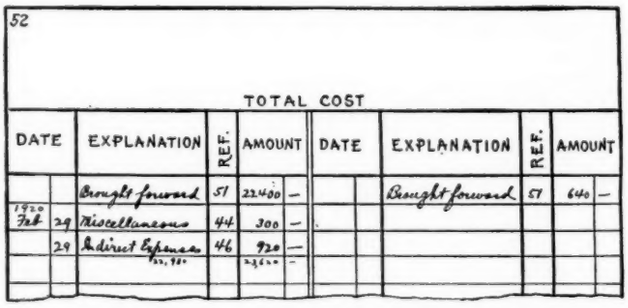


FIG. 4. FINAL FEBRUARY ENTRIES IN THE "TOTAL COST" ACCOUNT

our charges does not alter the fact that we have earned the amount charged to them. Being something that we have earned, when we enter the transaction in our journal we enter it in the right-hand column. Our journal entries for our charges to the various departments will therefore look something like Fig. 1.

From Fig. 1 it will be evident that we have introduced a new class of account. Up to now our general divisions have been,

(a) Direct Expenses
(b) Indirect Expenses } (A) Total Cost
(c) Investment

We now must add another type, Income, so that our list will be

(a) Direct Expense
(b) Indirect Expense } (A) Total Cost
(c) Investment
(d) Income

It will be remembered that each subdivision of the Direct Expenses was represented by a separate account in the ledger, whereas in the case of the Indirect Expenses and Investment only one ledger account appeared for each, so that in the latter cases all the subdivisions were posted to the one account in the ledger. Either of these methods could be followed in the case of Income. Thus, our general Income account is made up as follows:

(d) Income
1. Income from Dept. A
2. Income from Dept. B
3. Income from Dept. C

Hence, we could have an account in the ledger for "Income from Dept. A," another for "Income from Dept. B," and so on. Or we could have a single account headed "Income," and post to this one account all the items of that class. This latter method will prove the more practical in our case. There will be only one posting for each department at the end of each month, so that should occasion to do so arise, we could readily pick out all the charges for any one department on very short notice. On the other hand, we would secure the

60

INCOME

DATE	EXPLANATION	REF.	AMOUNT	DATE	EXPLANATION	REF.	AMOUNT
				1920 Jan. 31	Dept A	21	6300 —
				31	Dept B	21	2100 —
				31	Dept C	21	4200 —
				Feb. 29	Dept A	30	5250 —
				29	Dept B	30	1785 —
				29	Dept C	30	3780 —
							23415 —

FIG. 5. THE "INCOME" ACCOUNT FOR JANUARY AND FEBRUARY

advantage of having all the postings in one account, from which we can readily obtain our total for all the departments together.

Having settled this point, we look for a vacant page in our ledger, one coming after all the other accounts. We head this "Income" and then turn to the first page, where we should have a memorandum of all the accounts in the ledger together with the number of the page in the ledger on which each is to be found. To this list we add the Income account, followed by the number of the page which we have set aside for it. We are then ready to make postings to the account whenever we run across any entries for it in the journal. Let us proceed to post the entries shown in Fig. 1. When we get through, the ledger page would look something like Fig. 2, in which the small figures are the sum obtained by adding the various items; namely, $12,600.

It has been assumed in our example that the cost of generating the power was $12,000, leaving a profit of

	DATE	CLASS	DETAILS	AMOUNT LEFT	AMOUNT RIGHT
	1920 Jan. 31	Profit & Loss	Profit on Current		600 —
	1920 Feb. 29	Profit & Loss	Loss on Current	165 —	

FIG. 6. "PROFIT AND LOSS" ITEMS ENTERED IN JOURNAL

$600. The total of $12,000 would be arrived at from our Total-Cost account, which might look something like Fig. 3. We now come to the point where we are concerned with recording the profit. As just indicated, we obtain the amount of profit by subtracting the total of the Total-Cost account from the total of the Income account. It must be remembered that when we speak of the totals of the accounts we mean the totals for each month. In Fig. 2 and Fig. 3 it is assumed that the accounts were started on Jan. 1, so that the totals shown are those for the month. At the end of February the Total-Cost and the Income accounts looked like Fig. 4 and Fig. 5 respectively. From them it will be seen that the total cost to the end of February is $22,980, and that the total income is $23,415, showing a profit of $23,415 — $22,980 = $435 for the two months, January and February, combined. The cost for February alone, however, would have to be obtained by subtracting the total at the end of January from the total at the end of February. Making this subtraction would give us $22,980 — $12,000 = $10,980, which would be the total cost for February. Performing a similar subtraction for the Income account, we have $23,415 — $12,600 = $10,815, which represents the total income for February. Comparing the results, we see that the cost is greater than the income. That is, we lost money in February instead of earning a profit, and the amount of this loss would of course be $10,980 — $10,815 = $165. In January we made a profit of $600. Subtracting from this the loss in February would give us the net profit for the two months. Performing this subtraction gives us $600 — $165 = $435, the net profit for January and February combined. We see that this agrees with the result obtained earlier in the paragraph by subtracting the two months' cost from the two months' income, thus providing the accuracy of our figuring.

Having obtained the amount of the profit or of the loss by finding the difference between the monthly totals

of the Total-Cost and Income accounts, we are ready to make a record of the amount. Since the journal is our universal record book, we make an entry in it of the amount. For January and February the entries would look like those in Fig. 6. In January we are receiving a profit of $600, hence we enter the amount in its right-hand column. In February we lose $165, which is equivalent to paying out that much more than we receive, consequently this amount is entered in the left-hand column as are all items that we pay out.

From the entries we see that we must add still another account to those we already have in the ledger; namely,

64

PROFIT AND LOSS

DATE		EXPLANATION	REF.	AMOUNT	DATE		EXPLANATION	REF.	AMOUNT
1920 Feb.	29	Loss	0	165 —	1920 Jan.	31	Profit		600 —
							435 —		

FIG. 7. "PROFIT AND LOSS" ACCOUNT FOR JANUARY AND FEBRUARY

a Profit and Loss account. A complete list of the accounts would now be:

(a) Direct Expenses
(b) Indirect Expenses } (A) Total Cost
(c) Investment
(d) Income
(e) Profit and Loss

The one that we have added—that is, (e)—is equal to the difference between (d) and (A). We must set aside a page for it in our ledger and enter its title and page number in the index that we have established on the first page of the book. Having done so, we can post journal entries to it. If we assume that we have posted those for January and February, our ledger account for Profit and Loss would look like the page illustrated in Fig. 7. The small figures, as usual, show the difference between the two sides; that is, the net total to date.

As already explained, we cannot look upon the profit shown as really belonging to us until the power has been sold. That is, until the goods that the power helped make have been sold to some customer. When that happens, we may consider the profit as being available for use. Just what we do then will be the subject of our next discussion.

Rope-Drive Precautions

The subject of rope drive is given attention in a recent issue of the *Travelers Standard*, the Travelers Insurance Co.'s monthly magazine, and several good suggestions are made for securing safe and economical operation.

A pure manila rope is advised as being best for power transmission. In order to keep its deterioration down to a reasonable limit, the sheaves over which it is run should have a pulley diameter equal to at least forty times that of the rope, when the speed is around 4,500 ft. per min. At 3,000 ft. per min., the sheave diameter may be only about twenty-seven times that of the rope, as deterioration is not so pronounced at lower speeds.

An important question is the angle of the groove in the main pulleys. A very steep groove grips the rope securely, but on the other hand it causes too great an amount of wear and uses additional power because the rope tends to stick. A very shallow groove is likely to result in slippage and excessive wear. A 45-deg. angle V-groove is recommended, and it is said that experiments have shown that an angle smaller than 40 deg. should not as a rule be used. Half-round grooves in cast-iron pulleys have proved unsuccessful on account of slippage. With wooden pulleys, however, it is better practice to use the half-round grooves than the V-groove, because the coefficient of friction between the rope and the wooden pulley is about 40 per cent greater than for an iron pulley. Therefore, the rope will be gripped securely enough by the round groove and will not wear out rapidly.

The different grooves on the main pulley should be as nearly as possible uniform in shape, smoothness and especially in diameter. If there is any difference in the diameter of the groove, the situation is the same as though two belts running at the same speed were to drive different-sized pulleys on the same shaft; it is evident that slippage would inevitably occur. This would be most noticeable in the English (or separate-rope) system, but would still be objectionable in the American (or continuous-rope) drive.

Great care should be taken to keep the rope from breaking, not only from danger of loss of life, but also of the probability that a broken rope will become tangled with the others and cause a shut-down. Various warning devices have been installed, many of them consisting of a wire so placed that a piece of broken rope flying loose around the pulley will strike it and close an electric circuit, so that a bell will ring. The ropes should be inspected frequently for signs of failure.

When power is to be transmitted over more than 100 ft., wire rope is commonly used, and by setting up successive pulleys 350 to 400 ft. apart, it is practicable to carry the drive several thousand feet.

Wire rope is from three to six times as strong as manila rope, according to the manufacturers, but it must be remembered that this does not apply to short drives, where wire is generally found unsatisfactory.

As wire rope is much less flexible than manila rope, the size of the sheaves and pulleys must be considerably greater. If a so-called 6 x 7 wire rope (composed of six strands, each having seven wires) is to be used, the sheave diameter should be at least 100 times that of the rope. Better results will be obtained if the sheave diameter is from 125 to 140 times the rope diameter.

Wire rope should not be run over a bare iron sheave; the bottoms of the grooves should be recessed and filled with wood blocks, leather, or rubber. It is said that the best results are obtained by the use of rubber sections separated from each other by pieces of leather. The filling should not be flat, but should have a slight circular depression in which the rope can rest.

The sheaves should be perfectly aligned and the shafts should be parallel, as otherwise rubbing, side-swaying and jerking will be likely to result.

A new wire rope will be likely to stretch somewhat during the first few months of service, making it necessary to take up the slack. Tightener-sheaves should seldom be used; the rope should be shortened and the ends respliced, and this should be done by a thoroughly experienced workman.

In cases of either wire or manila rope drive, wherever there is possibility of anyone walking into the ropes, suitable guards should be set up. If the lower rope is over 8 ft. from the ground, no guards need be used, except for one under the rope to prevent its falling upon anyone walking underneath.

EDITORIALS

Three Parties in Interest

THE threatened disturbance of coal-mine operation by the injunction against the "check-off," or deduction of union assessments from the miners' wages at the source, which for a time looked serious, seems to have passed the critical stage. However, this is merely a postponement, for the issue will surely arise again.

The miners as individuals are probably little concerned in the matter. It is the mine labor organizations involved that are the first party in interest. These organizations are, however, loath to press a decision at the present time; they would much prefer to defer any controversy that may lead to a strike at least until the spring. By such delay the union treasury will be in much better shape to withstand the drain of a strike. Just now, following the slack of low production, the funds on hand are abnormally low. Furthermore, the labor leaders realize that any controversy at this time with low stocks of coal and increasing demand of the winter season would inevitably require early settlement and would probably not be as satisfactory to them as a strike coming in the spring with the lesser public demand for immediate adjustment of affairs.

The coal operators, individually and collectively are, of course, the second party at issue. They would decidedly favor an immediate adjustment of this controversy. They anticipate that a strike at this time would bring labor into disrepute with the public and greatly increase the chance of a lowering of wages and an adjustment favorable to the coal situation generally. Their only fear is that a controversy just now would so arouse the public and public officials that drastic legislation would follow. This, of course, the operators dread although favored by the miners. Despite this fear, however, it is not unlikely that they would venture a prompt effort for the settlement of the objectionable "check-off" system if a strike were actually undertaken. They believe particularly that by using this occasion they could place the responsibility upon the labor organizations for having disturbed public-service facilities, since the strike would be really against the Government decision and not against themselves or the wage features of their contracts with the miners.

The third party in interest is, of course, the public, and as usual it is the party most concerned but least noticed in all discussions. No matter how things go, the public is going to pay the bill, as usual.

Studying the Problems of Industry

WITH the publication in book form of American Engineering Council's report on the elimination of waste in industry, those responsible for results in the six industries that were investigated will have the opportunity of examining the findings of the Council's committee with a view to applying them to their problems. The report undoubtedly contains data that will prove valuable. The fact that it is presented upon the authority of the committee, and not formally as a work of American Engineering Council itself, detracts somewhat from the standing that it otherwise might have had. The Council's attitude appears to be that the committee's findings should be accepted with judgment for what they are worth.

It is unfortunate that the investigation of the coal industry had to be abandoned. There is a great deal of waste in that industry and great opportunities for improvement. The coal business suffers chiefly, however, from ills of an economic and political nature, and of such a character must be the remedies that are applied. Perhaps it was that fact that moved the committee to give up the coal report.

Consideration of the report and of the present industrial situation indicates that purely mechanical problems are becoming of less importance than economic difficulties. In past years man's constant effort has been to improve manufacturing processes, to substitute machinery for hand work, and to turn out various products more quickly and more cheaply. That effort has met with almost inconceivable success, but in late years a greater problem has arisen, which unfortunately becomes more complex as the manufacturing process becomes more efficient. The success of a business has come to depend less upon the actual production efficiency of its factory and more upon the astuteness of its officers in influencing the market through methods that often have a bad effect.

That fact is food for thought on the part of engineers, who should come to realize that their success will depend not alone upon their understanding of technical questions, and their engineering knowledge, in the common use of the term, but also upon a broad understanding of economics and politics.

Locating Electrical Troubles

FAULTS in electrical equipment and circuits can occur under so many conditions and the apparatus is so varied that it is extremely difficult to evolve any hard and fast rules for locating them. The equipment may vary from a simple squirrel-cage motor started with a knife-switch to a modern high-speed elevator with all its circuits for controlling, starting, stopping and adjusting the speed of the machine, as well as the numerous safety devices. When electrical equipment is in trouble, the method of locating the fault will depend largely upon the man and how the apparatus acts. Men of equal qualifications will attack the problem differently, especially if the difficulty is one of the perplexing kind.

Faults may be divided into two classes: Those that are of a permanent character, that prevent the equipment from operating, or produce certain objectionable effects until removed, and those that are of a transient character, which may cause a fuse to blow or other bad effects but temporarily cleared when this occurs. The latter condition is a difficult one since there is little for the tester to work on as to the probable cause, except his own judgment. Almost any experienced trouble man

can recall cases where trouble has occurred on equipment intermittently for weeks and even months before the real cause was discovered. Fortunately, such problems are in the minority, and usually there is some indication to give a clue where to look for the seat of the trouble. With the intermittent fault, its location can be dealt with only by the experienced tester, one who is familiar not only with the characteristics of the circuits but also with those of the equipment, or is capable of finding them out for himself.

A fault that develops and stays on the equipment is generally easily located unless it develops from a combination of causes, and even then it will be found that when the ordinary tests for grounds, open circuits and short-circuits are made, at least some of the contributing causes will be indicated. It is with this class of faults that the article, "Locating Electrical Troubles on Elevators," in this issue, deals. However, before the problem can be attacked intelligently, one must be familiar with the characteristics of the power circuits and what may constitute a fault, and this the author has attempted to do before showing how the trouble may be located. The method applied is what may be called a process of elimination and has proved to be one of the most successful in locating defects. Of course the best that can be done is to indicate the method of attacking the problems; it remains for the man himself to apply them, since it is seldom that two cases of trouble occur under the came condition.

The Internal-Combustion Engine

THE history of the internal-combustion engine is of much shorter length than that of the steam engine, for it was not until the latter had been in use for over fifty years that a successful prime mover using gas was produced.

The advances made in design since the first combustive free-piston gas engine was hailed as epoch making is well illustrated in the present-day high-speed engine producing a horsepower for each two pounds of engine weight. The improvements in design have been followed by a more general use until at present there are in the United States at least five times as much horsepower in internal-combustion engines as in steam turbines and steam engines. The enormity of power of the steam-power plants in any state is completely overshadowed by the horsepower of engines using liquid or gaseous fuel. Furthermore, the annual production of the internal-combustion engine is increasing much faster than is the steam-engine manufacture.

The tremendous output of automobiles, tractors and gas and oil engines carry a message that all should heed. If the supply of liquid fuel is to last for any considerable period, the engines must be operated at their maximum efficiency. Every engineer or owner of an engine should see that economy is secured. As a further step in fuel conservation oil should not be wasted by burning in the boiler furnace.

Boiler-Fuel Efficiency

ONE of the advantages possessed by boiler oil over coal as a boiler fuel is the increased efficiency secured in every-day operation. The mixing of the fuel with the air is far nearer perfect than is usually obtained when burning coal. The process of combustion can be controlled by automatic regulators and is less subject to mismanagement by the boiler-room force.

Unfortunately, the supply of boiler oil is limited and will steadily decrease as the petroleum fields are exhausted. The majority of power houses will never be able to use oil and a substitute having the automatic-control characteristic of boiler oil must be sought for.

Heretofore, pulverized coal has been recognized as an ideal fuel, but methods of handling this fuel have precluded its adoption save in large power houses. It has been generally stated that pulverized coal cannot be used economically in a boiler plant consuming less than fifty tons a day. The majority of plants of course consume much less and as a consequence have been forced to adhere to hand or stoker firing.

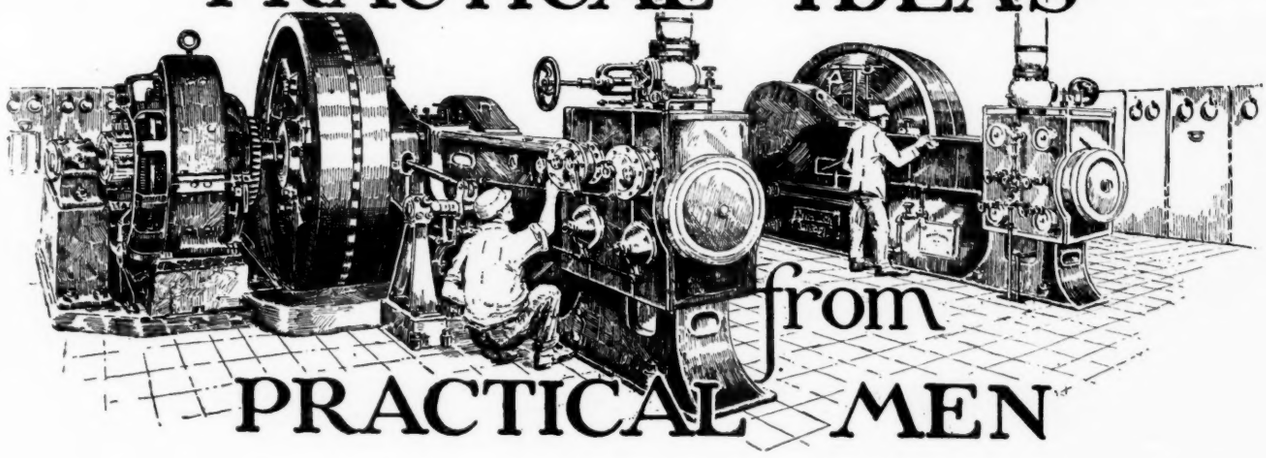
There is a great need at the present time for a system of pulverized-coal handling and burning that can be applied to plants using as little as ten tons a day. Such a system must be comparatively inexpensive, devoid of any great amount of accessories and of a design to allow its application with few changes in the boiler-room structure. This is a field that offers great opportunities for the engineer.

Henry Ford, the irrepressible, has taken the railroads to task of late with his characteristic disregard of time-honored traditions and generally accepted theory. He has become interested in railroading since his acquisition of the little Detroit, Toledo & Ironton. He thinks there are many things radically wrong with the railroads, with which most of us will in large measure agree. He is especially intolerant of what he terms the "parasite" stockholder. He advocates getting rid of the present kind of capitalists and having the railroads owned by the employees. Among many other criticisms he says: "Most railroads have enough lawyers working for them to operate them if they were engaged in useful work." The point has truth in it, but the railroads are not the only offenders in this respect. It is popular to criticize the railroads; let us turn to our own field. Some of the larger utility companies have employed an array of counsel that put them in a class with the railroads. It is discouraging for an operating man to try to pull down the cost per kilowatt-hour, when a considerable part of the total cost comes from various "overhead" expenses paid with scant attention to economy.

In a hearing on the Metric bill, which is a mooted question in Washington at this time, there was an amusing tilt between the chairman and a witness appearing in favor of the bill. Professor Bingham had been asked how long it would take an average man to familiarize himself with the metric system, and he answered that it would take about half an hour. At which the chairman remarked "You hold the record for educational results." However, it is not so much a question of how long it takes a man to learn the system; the chief objection against the adoption of metric standards is the tremendous expense involved in changing our manufacturing equipment, measuring instruments, etc., in accordance with metric units.

One of the primary purposes of a power plant is to supply power for all kinds of lighting, yet the provision made for lighting some power plants would indicate that good illumination was something to be avoided. It is time that cognizance was taken of what is being done to obtain better illumination in industries and some of these principles applied to lighting various parts of the power plant.

PRACTICAL IDEAS from PRACTICAL MEN



An Ammonia System Filled with Gas

A short time ago I was employed by the manager of a refrigerating plant to fill the vacancy caused by the engineer resigning. The first day I went to work, I found the discharge pressure exceedingly high, being around 190 lb. gage pressure. The pressure corresponded to a condensing temperature of 97 deg. F. The cooling water never needed 70 deg., and even 150 lb. condenser pressure is high for this water temperature.

I thought that the valves on the condenser outlets might be partly closed, but investigation showed they were wide open. It was then assumed that the condensers, which were double-pipe ones, might be heavily sealed. Upon pumping out one stand and opening the bends, no scale was found. We were getting desperate by this time, as one reason the firm employed me was my claim that I was a real refrigerating engineer.

After studying the situation, the only possible reason for the high pressure and poor operation so far overlooked was non-condensable gases. Proceeding on this theory, we attached a hose to one of the condenser purge valves and inserted the other end in a pail of water. The inert, or non-condensable, gases bubbled up until the ammonia gas started flowing into the water, whereupon the bubbling gave way to the loud cracking caused by the ammonia gas condensing in the water. This purging helped to lower the pressure, but by no means as low as was desired.

I figured that a lot of inert gas was still in the coils, mixed with the ammonia gas. If we removed all of it, a lot of ammonia would be lost. So it was decided to close the intake valve in half of the stands and operate the plant with the rest of the stands, closing most of the expansion valves. The receiver then filled up and the liquid finally filled the stands almost to the top. In the stands having the intake valve closed, the liquid backed up, forcing the inert gases and the small amount of ammonia vapor mixed with the gases into the top of the stand. The pressure was kept at 200 lb. and the stands cooled down to 75 deg. At this temperature practically all the ammonia gas was liquefied. By opening the purge valve, the gases were blown out into the water bucket.

After going over each stand of coils, we found that the discharge pressure could be kept at 145 lb. gage with no trouble.

J. CASSIDAY.

Jersey City, N. J.

Paralleling Compound-Wound Generators

Since there seems to be a difference of opinion as to what is the best practice to follow in paralleling compound-wound generators, I would like to express an opinion based on seventeen years' experience in the erection and operation of generators, rotary converters, etc. Our construction rules called for three single-pole knife switches—positive, equalizer and negative—with a circuit breaker placed in the negative lead, which is the armature connection, as in the figure.

Assuming the incoming generator to be up to speed and having proper polarity, as machine *B* in the figure, the method of paralleling is to first close the circuit breaker; second, close the equalizer; third, close the positive switch; and last, close the negative switch. I have seen generators paralleled in this way when there was 10 per cent difference in the voltages, and have paralleled them with no bad results when the generators in service were pulling 100 per cent overload.

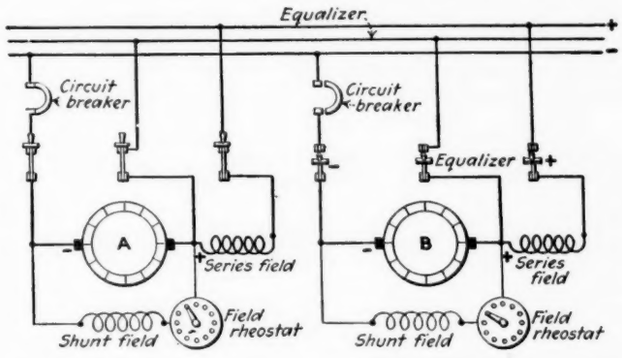


DIAGRAM OF TWO COMPOUND GENERATORS IN PARALLEL

Of course the voltages ought to be the same, but by closing the equalizer first, the machines will tend to adjust the difference. This method is used in paralleling rotary converters with rotary converters, rotary converters with motor-generator sets, motor-generator sets with gas-engine-driven generators and motor-generator sets with steam-driven generators. These generators varied in size from 150 to 900 kw., and the percentage of accidents due to paralleling has been very low and mostly caused by operators neglecting a polarity test.

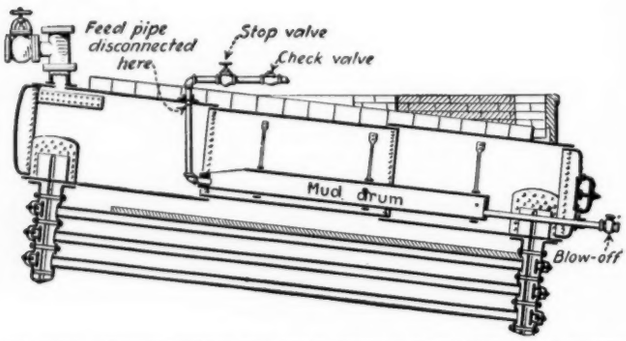
M. A. ANDERSON.

Pittsburgh, Pa.

Hammering in the Boiler-Feed Line

A mysterious case of hammering in the feed line happened in a plant shortly after a boiler had been installed. Whenever the feed line was in operation, hammering would occur, so severe that it literally shook the joints loose.

The plant engineer concluded that something was wrong with the check valve, so he purchased a new one and put it in the line. This had no noticeable effect



WATER CONNECTION TO MUD DRUM BECAME DETACHED

on the hammering, and I was sent to examine the boiler. I found that the internal feed pipe had been disconnected in some way in one drum, and apparently the relatively cold incoming feed water coming in contact with steam produced condensation and consequent violent water hammer. The check valve had no effect except at times when there was no water flowing through the valve.

In this case the function of the internal mud drum ir purifying and heating the incoming water was overlooked. By connecting up the feed pipe properly, the water was discharged into the mud drum and retained for a sufficient time to precipitate impurities and bring up its temperature before it entered the circulation path of the boiler. This procedure cured the difficulties, and no trouble has since been experienced.

R. F. BURKE,
Investigating Engineer, Heine Boiler Co.
St. Louis, Mo.

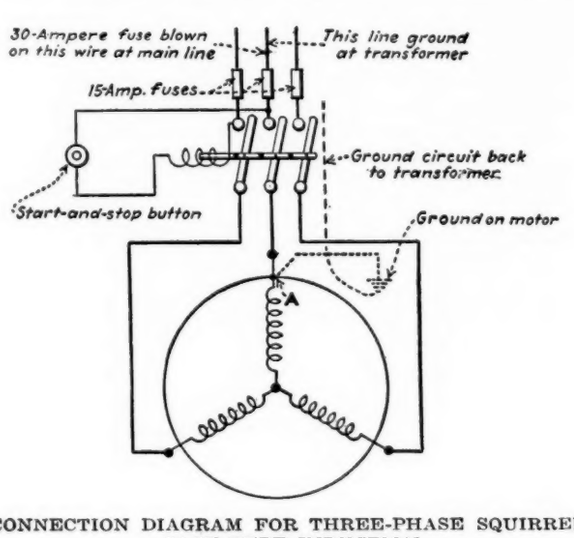
Three-Phase Motor Apparently Starts Single-Phase

A case where a three-phase motor apparently started on a single-phase circuit recently came under the writer's observation. The new electrician on the job was asked to look after a push button on a remote control for a 3-hp. three-phase motor. The motor would not start when the starting button was pushed, but would start and continue running when the magnetic switch, controlled by the button, was closed by hand. It would also stop promptly when the stop button was pushed.

At the first opportunity the push button was taken apart, and was found to be in good working order. Next, the binding posts on the magnetic switch to which the push-button system connected were short-circuited with a jumper so as to have the same effect as pushing the button, but eliminating the push button and wiring, but the motor failed to start. The next move was to test the switch with a lamp to see if all phases were alive; this showed one phase to be dead. Three 15-ampere fuses protected the motor, and all three were found good. Back where the branch circuit left the main line a 30-ampere fuse was found blown. When this fuse was restored, everything was in apparent good order and the motor responded to push-button operation.

Many electricians would have considered their work finished after replacing the blown fuse, but the man on this job felt that he must answer the question why the motor appeared to start and run on single-phase. The importance of having the motor always ready for service and running most of the time kept him from giving the matter a thorough investigation at once, but he kept trying one thing after another, when there was an opportunity, until he found the trouble.

His first thought was that a split-phase effect might have been obtained through the coil of the magnetic switch. A test showed that this was not the case. While the motor was running, a ground was discovered on one phase. Tracing back, one phase of the system was found grounded at the transformers. When the motor could be shut down, it was tested and a ground found on one of the leads where it entered the motor, as at *A* in the figure. This happened to be on the same phase as the ground at the transformers, and this solved the mystery. The two grounds completed the circuit for this phase, and when the switch was closed by hand, the magnet received current through these grounds and



CONNECTION DIAGRAM FOR THREE-PHASE SQUIRREL-CAGE TYPE INDUCTION

the switch was held closed. The ground at the motor was removed, and the motor would no longer start with the fuse out.

This experience is only another argument that maintenance men should not be content with curing the apparent trouble, but should persist until all unusual behavior is accounted for. G. E. MILES.

El Centro, Cal.

Primary horsepower in New York state increased 12 per cent from 2,356,655 hp. in 1914 to 2,639,001 hp. in 1919, according to a preliminary statement from the Census Bureau on the general results of the 1920 census of manufactures. It is interesting to compare the figures for New York with those for New Jersey and California. Primary horsepower in New Jersey increased 44.7 per cent from 703,063 hp. to 1,147,268 hp., and in California it increased 56.6 per cent from 491,025 hp. to 768,858 horsepower.

CORRESPONDENCE

Why Do the Lights Flicker?

In answer to W. J. Groom's communication, page 611 of the Oct. 18 issue of *Power*, I do not understand whether his lights flicker continuously or only at times when motors start. If the flicker is continuous, he may remedy the trouble by having a heavier flywheel, or he may find out by using an indicator that the valves are not set correctly. Valves that are a little off would not make any difference, but they may be off enough to cause trouble. If the valves are off there will not be the same compression on both diagrams and the admission will also be different at each end of the cylinder. If the flickering comes at times when motors start, proper governor adjustment and a heavy flywheel will no doubt overcome this to a great extent.

First of all, I would look over the governor. Some high-speed engine governors are very sensitive and the least wear in the governor pin or sticking at this point will cause trouble.

I have had considerable experience with high-speed engines on motor loads, and all the trouble with flickering I had came when motors were started and stopped. A heavy flywheel is about all that is needed.

Chicago, Ill. L. B. SHIELDS.

W. J. Groom, in his inquiry, does not give sufficient details regarding the installation and conditions, on which to express an intelligent opinion, therefore, the best that can be done is mere conjecture as to the probable cause. On a 25-cycle alternating-current circuit, carbon-filament lamps will give a distinct flicker in the illumination, whereas with tungsten-filament lamps this flicker is noticeable only in the filament itself, the flicker not being noticeable in the illumination away from the lamp. With alternating-current machines a fluctuation in the exciter voltage would be transmitted to the alternating-current circuit and would cause flickering of the lamps. Fluctuating voltage in an exciter might be due to any of the causes for the same in any direct-current generator.

In direct-current generators loose connections, poor condition of the commutator would cause variations in the voltage sufficient to produce flickering in the lamps. Fluctuating loads on the system may cause voltage variation sufficient to produce flickering of lamps. Air compressors, punch presses or similar devices, on which the flywheels are too light, will take a fluctuating current from the generator. Frequent starting and stopping of heavy loads such as elevators may cause a flicker in the lamps each time the motors are started.

If the load on the system is fairly constant, it is a pretty sure guess that the trouble is in the machine, either the generator or engine. If the engine is not pounding and the flywheel has sufficient weight, then the trouble must be in the governor, which may be sluggish, due either to wear or to misadjustment.

Boston, Mass. CHARLES A. ARMSTRONG.

Referring to W. J. Groom's question, "Why Do the Lights Flicker?" since a high-speed engine is used, I would suggest that he look over the field connections of the generator carefully, as it is possible that the vibration of the engine causes a loose connection to make and break enough to make the lights flicker.

Lisbon, Me. C. R. WARD.

Taking Indicator Diagrams

Mr. Cassiday, in *Power* of Oct. 25, takes me to task for a statement made in reference to taking indicator diagram. Mr. Cassiday has evidently misunderstood my statement in a number of places, particularly as to looseness of the indicator piston and its effect on the indicator diagram. In my discussion, which appeared in *Power* of Oct. 11, I stated that the indicator piston was loose on the stem when the diagram Fig. 2 was taken and not loose in the indicator cylinder. This looseness of the piston on its stem introduces a pencil lag, as the indicator piston moves without transmitting motion to the pencil. When this lost motion has been entirely taken up, the piston suddenly strikes the shoulder of the stem and the blow causes the pencil motion to rise rapidly. Sticking of the piston will cause the sudden jumping, as Mr. Cassiday states, but when this occurs there is usually further indication of sticking shown on the compression line by a series of waves.

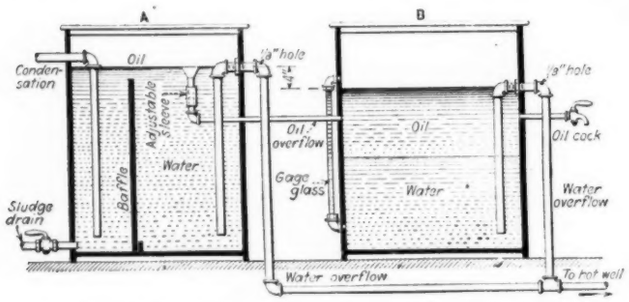
The Fig. 4 referred to by Mr. Cassiday was, unfortunately, not reproduced exactly as the original pencil diagram showed. As I stated in the original discussion, the shape of the re-expansion line does indicate a weak drum spring and stretching of the indicator cord. At the beginning of the stroke the drum is at rest, and in starting in motion and accelerating the drum, the spring stretches and the drum tends to lag behind. Suddenly, the stretch of the cord ceases and the drum gets a jolt, causing it to overtravel, owing to the weak resistance of the drum spring. If the spring were stiff, it would resist the sudden inertia of the drum. This all combines to distort the expansion line as shown. The indicator diagrams were not made to scale, but were somewhat exaggerated.

Flushing, N. Y. PAUL A. BAUMEISTER.

Home-Made Oil Separator

In many plants there are a number of low-pressure traps discharging hot water heavily laden with oil. Usually, both the water and oil are wasted unless the installation is of sufficient size to justify the installation of a filter and purifier, in which case the heat in the water is recovered and the oil may be used again for certain purposes.

At small expense an oil separator can be made from two tanks or barrels and some pipe fittings, which will



DETAILS OF CONSTRUCTION OF HOME MADE OIL SEPARATOR

speedily pay for its cost in the saving of cylinder oil alone, besides adding materially to the hot-water supply.

Such an installation is shown. The operation is as follows: The oil-bearing hot water comes from the traps into the tank *A*, where some separation takes place and the oil rises in the current of water and passes over the baffle. The funnel opening is just even with the water level in this tank, so that the agitation caused by the incoming water splashes the top layer of oil and water into the funnel and thence into the pipe leading to the storage tank *B*. The remainder of the water in tank *A* passes out through the siphon pipe from the bottom and carries no oil to the hotwell. A hole is drilled at the upper end of this pipe to prevent siphoning out too much of the water at once.

The oil overflow carries some water over into the tank *B*, where the oil remains in a strata at the top and the water passes out through a siphon pipe similar to that in tank *A*, but smaller. Both siphon pipes should be large enough so that at no time is it necessary for them to be more than half full.

The oil level should be watched in the glass and some drawn off before the gage fills; otherwise the action of the system is automatic. This salvaged oil is usually of good quality and may be used again for many lubricating purposes or even for steam-cylinder work if filtered.

D. R. SHEARER.

Johnson City, Tenn.

True Form of Water-Rate Curve

The application of the Willans-line principle to an analysis of the operating characteristics of a turbine or engine will often bring out points that would otherwise be passed over. An instance of this nature occurs in R. D. DeWolf's article on "Non-Condensing Turbine Operation on Heating Load," which appeared in the issue of *Power* for Aug. 9.

It will be noted that the author furnishes a chart of non-condensing water-rate curves for different back pressures which have been drawn from the manufacturer's guarantees. The curve *ABC* of Fig. 1 has been replotted from the values given in the article for 5 lb. back pressure. The shape of this curve indicates that the water rate is decreasing very rapidly at the full-load point, which is to be expected, but scarcely at the rate shown. The application of an overload, say of 100 or 150 kw., would evidently have the result of reducing the water rate to the vanishing point.

No doubt Mr. DeWolf felt that there should be a closer agreement between the actual steam consumption and the steam consumption indicated by the curves, but by neglecting to discuss the question on the basis of total steam flow, he failed to establish the relation.

The following table is taken from the article mentioned:

Average Load Kw.	1919-20 Actual Steam Consumption Lb. per Kw-hr.	Consumption for 5 lb. Back Pressure Lb. per Kw-hr
263	57.7	47.3
355	48.0	47.2
457	47.7	46.8
538	49.0	46.4
686	44.4	44.4

Values in the last column have been read from the water-rate curve as shown in Fig. 1, and although these correspond to the load points for which actual steam consumption figures are available, it is apparent that the two columns do not agree.

The Willans-line principle states that the total steam consumption of a throttle-governed engine is a straight-line function of the load. That is, the total flow of steam, in pounds per hour, plotted against load on the engine will locate a series of points that lie in a straight line. The same characteristic has been proved to hold for all throttle-governed turbines.

The total steam consumption in pounds per hour is obtained from the table already given by multiplying the water rate by the load. The results are as follows:

Average Load Kw.	1919-20 Actual Steam Consumption Lb. per Hr.	Consumption for 5 lb. Back Pressure Lb. per Hr.
263	15170	12440
355	17040	16750
457	21800	21390
538	26360	24960
686	30460	30460

The figures in the last column have been plotted as the "total-flow" curve in Fig. 1. It is evident that this is

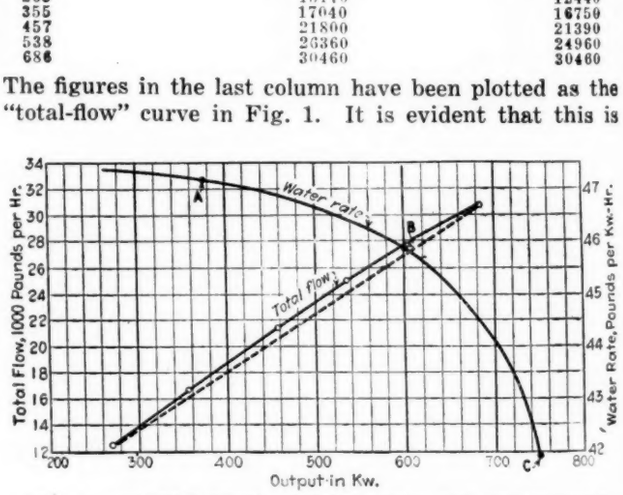


FIG. 1. WATER-RATE CURVE FROM MR. DE WOLF'S ARTICLE AND CORRESPONDING TOTAL-FLOW CURVE

not a straight line and therefore cannot represent the true steam flow of the turbine. On the other hand, the guaranteed points *A*, *B* and *C* of Fig. 2, corresponding to *A*, *B* and *C* of Fig. 1, do not lie in a straight line. The explanation for this lies in the fact that the turbine is equipped with two sets of nozzles which is, in effect, equivalent to building two turbines in the same casing.

We know that the points *B* and *C* in Fig. 2 are obtained when operating with both nozzles, therefore some Willans line will pass through both of them. This line has been drawn, and it is seen to intersect the load axis at *E*. The distance from *E* to zero represents losses due to overcoming inertia, friction losses, generator windage losses, etc., and may be regarded as the negative effort required to bring the machine up to normal no-load

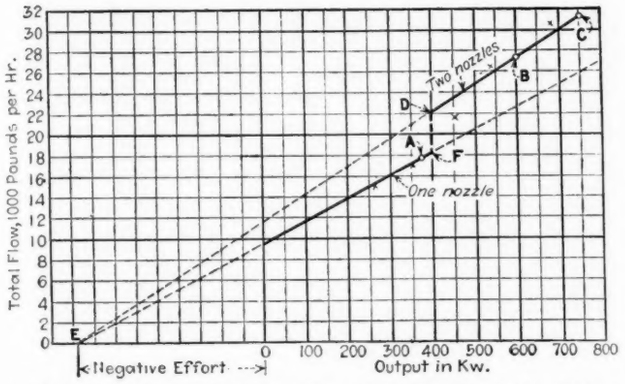


FIG. 2. WILLANS LINES FOR ONE NOZZLE AND FOR TWO NOZZLES

speed. Evidently, this effort will be the same whether one or two sets of nozzles are in use, and therefore another Willans line will pass through *E* and *A*, the latter being a guaranteed point when only one set of nozzles is employed.

Having the two flow lines, we now wish to connect them so as to draw the water-rate curve for the turbine. It is stated that the first set of nozzles is adequate for loads up to about 350 kw. If it is assumed that the second set of nozzles is put in operation at a point 5 per cent in excess of the guaranteed capacity of the first set, we shall be reasonably close to the truth. The 400-kw. point is selected as being convenient and sufficiently accurate. The vertical line *DF* is then drawn intersecting both Willans lines, and the resulting line *EAF DBC* is accepted as the flow curve for this machine. That this curve represents the operating characteristics of the turbine is attested by the fact that the points marked with the crosses are actual points taken from the daily records.

The sudden jump in steam consumption caused by opening the second nozzle is due to the fact that the nozzle area is momentarily too great for the load, so that there is excessive throttling.

By reading points from the flow curve and dividing by the load at which they are read, a water-rate curve may be drawn as shown in Fig. 3. Water rates read from this curve will agree very closely with the actual observed water rates. A water-rate curve of this type applies only when a turbine is operating under conditions for which it is designed. However, performance studies based on this and similar curves should enable an operator to control conditions to his advantage.

Lynn, Mass. PAUL CHRISTOPHER.

[Mr. Christopher's letter was submitted to Mr. DeWolf, who replied as follows.—EDITOR.]

The discussion contributed by Mr. Christopher on my article published in *Power* for Aug. 9, 1921, brings out very interestingly and clearly a feature of water-rate curves of turbines using one or more nozzles which had been partly intentionally and partly unintentionally ignored. The first table included in my paper of Aug. 9, comparing the actual steam consumption in pounds per kilowatt-hour with the consumption taken from the 5 lb. back-pressure curve was intended to be used only in a very general way, keeping in mind the fact that the points on the water-rate curves were taken with a different number of nozzles in operation. This fact was not properly flagged, nor was it emphasized as it should have been in Fig. 1 of the article.

In Mr. Christopher's Fig. 3 he gives, of course, the true form of water-rate curves for this machine. The form under actual operating conditions is indeterminate owing to the fact that the number of nozzles in operation is not varied to suit the load conditions as frequently as it should be. Consequently, with the varying load on the machine there are times that two nozzles are in operation when there should be only one, and vice versa, and we can only draw very general conclusions as to what water rates should really be obtained.

One point should be mentioned in regard to the headings used in the issue of Aug. 9. Near the bottom of page 220 the heading "Water Rate Curves 1920-1921" is used. The curve to which this heading refers is really not a water-rate curve at all, but a kilowatt-hour per day generation curve for varying outside temperatures. The question of water rates enters into the paper to a very limited extent, the comparison in operating results being based on the daily generation rather than the water-rate curve. It should also be remembered that in the figures given for the actual water rate (in the second column of the table) the actual back pressures vary considerably with the average load, the back pressure in general being higher the greater the load. Thus on the 263-kw. load the back pressure probably

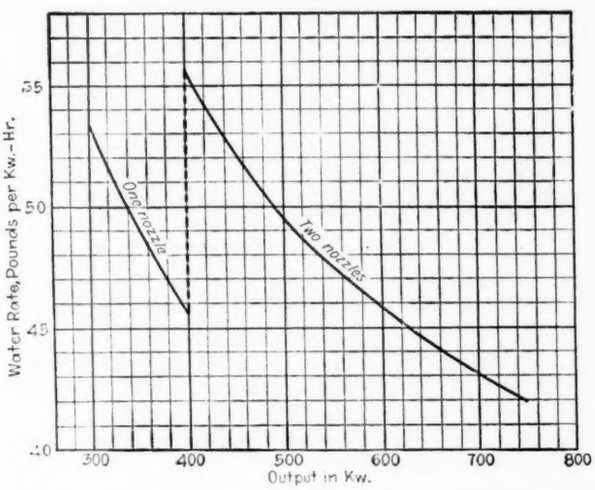


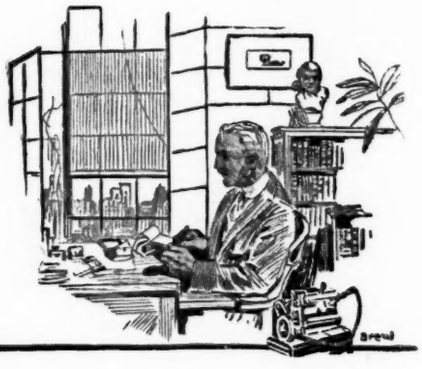
FIG. 3. WATER-RATE CURVE DERIVED FROM FIG. 2

averaged less than 2 lb., whereas on the 686-kw. load it averaged possibly more than 5 lb. Due to these variations it is evidently impossible to make accurate use of any water-rate curve, and it is not the purpose of the paper to recommend the use of water-rate curves for this purpose, but to bring out the operating advantages illustrated in Fig. 2, due in a large measure to substituting automatic for hand control on the turbine.

Rochester, N. Y. R. D. DEWOLF.

Practically the only object in compounding a steam engine is to reduce cylinder condensation.

QUESTIONS AND ANSWERS



Compensating Pressure Gages for Error Due to Elevation

For ascertaining the pressure in steam-heating pipe lines we have several low-pressure gages each located about 10 ft. below its point of connection with the line. Each gage indicates about 5 lb. above the actual pressure carried in the line. How can the gages be connected or corrected to indicate the pipe-line pressures?

E. W.

The excess of pressure shown by the gages is due to head of water in the connections resulting from condensation and, although the pressure due to the head varies with the temperature of the water, the variation is so small that for all practical purposes the excess of pressure indicated by a gage may be considered to be constant when the connections are filled with water. The simplest method of obtaining readings of a gage that would be true for the pipe-line pressures would be to set the gage pointer hand back to 0, or turn the dial forward, to obtain the indication of 0 pressure when the pipe-line pressure is zero at the place where the connection is made with the pipe line and the gage connections are filled with water.

Setting D Valve Without Removing Steam-Chest Cover

How can the D slide valve of a throttled slide-valve engine be set without removing the steam-chest cover?

R. M. C.

If there is a rocker for transmitting motion of the eccentric to the valve rod, for the best valve setting the length of the eccentric rod should be so adjusted that the rocker will swing approximately as far to one side as the other of the position in which it would be at right angles to the valve rod; and when the length of the eccentric rod has been thus adjusted, the valve setting would be completed by adjusting the valve rod to such length that one end of the valve will travel over the opening edge of its steam port as much as the other eccentric and then with the engine on a center, setting the eccentric to that position which will give the valve the desired amount of lead. If the valve-rod length cannot be adjusted outside of the stuffing box, it will be necessary for good valve setting to remove the steam-chest cover for that purpose. But where the rocker would be thrown only slightly out of perpendicular to the valve rod from adjusting the length of the eccentric rod, then a fair valve setting could be effected by simply adjusting the length of the eccentric rod for equalizing the travel of the valve without opening the steam chest; or in case there is no rocker, the equalization of valve travel could be performed by adjusting either the length of the valve rod or the length of the eccentric rod, without removing the steam-chest cover. For testing the equalization of valve travel without opening the steam chest, place the engine on a center, make a mark on the guide to correspond with a mark on the crosshead and set the eccentric on the shaft to that position which will just permit steam to be blown through the port at the same end. Then turn the flywheel forward to the position where by opening the throttle valve, a very little steam is shown by the pet cock to be admitted to the other end of the cylinder. Make a mark on the guide to correspond with the mark on the crosshead and also with the engine on dead center at the same end of the cylinder. Also make a mark on the guide halfway between the marks last made on the guide, then block the engine wheel to such a position that the mark on the crosshead will be opposite to this middle mark and adjust the length of the valve rod or eccentric rod so steam will be just admitted on the same end.

Next turn the engine forward toward the other center until the mark on the crosshead comes the same distance from the end of the stroke as the middle mark is from the other end. If steam is just admitted the travel has been equalized. If not, turn the engine to the position where steam is just admitted, make another mark on the guide halfway between the position where steam was admitted and the position where it should have been admitted, and with the crosshead set at this middle mark readjust the valve-rod or eccentric-rod length until steam is admitted at that end of the cylinder. With the valve travel thus equalized, place the engine on the head-end center, turn the eccentric forward on the shaft, and set the eccentric to the position at which steam is just admitted to the head end of the cylinder; then make a mark on the valve rod at the end of the stuffing-box gland and set the eccentric as much farther forward on the shaft as may be necessary to draw the mark made on the valve rod away from the end of the stuffing-box gland a distance equal to the desired amount of lead.

Earlier Compression When Running Condensing

Why should there be earlier compression of the exhaust of an engine when running condensing than when running non-condensing?

C. N. J.

The purpose of having the piston perform the work of compression of the exhaust is to obtain a cushion for overcoming inertia of the reciprocating parts of the engine so they may be more quietly brought to rest at the end of the stroke; and also to have the clearance spaces in the end of the cylinder filled with exhaust steam that has been compressed nearly to the boiler pressure when steam is admitted for the beginning of a return stroke.

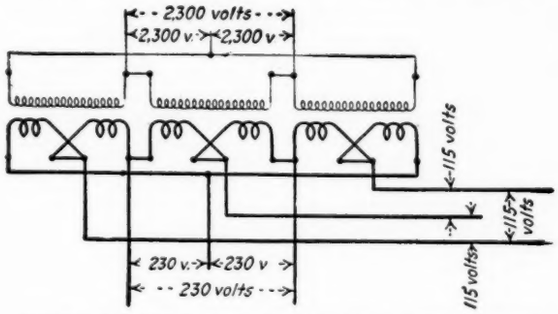
With compression beginning at a given point of the exhaust stroke, the lower the pressure of the exhaust steam that is trapped in the cylinder at the beginning of compression, the less will be the cushioning effect for bringing the piston to rest and the lower the final pressure of the compression. But for a given pressure of the exhaust, the earlier the beginning of the compression the greater the cushioning effect and the higher the final pressure. Hence, as the exhaust pressure is lower when operating condensing than when operating non-condensing, to more nearly obtain the same cushioning effect and compression as when operating non-condensing it is necessary to have the exhaust valve closed for beginning compression earlier in the exhaust stroke.

High Voltage from Three-Phase Transformers

We have a bank of three 100-kva. transformers connected delta to delta used to supply a three-phase 230-volt motor load from a 2,300-volt system. With the present delta connection is it possible to obtain 115 volts for a lighting load, without interfering with the motors?

T. A. C.

When the transformers are connected delta to delta, as in the figure, taps may be brought out from the middle of the secondary windings to obtain half voltage, or in this case 115 volts. Care should be exercised to distribute the lighting load on the three phases and also to prevent overloading any section of the secondary winding. The total load that can be connected to the



DELTA TO DELTA TRANSFORMER CONNECTIONS

transformers will depend on the percentage of load that is placed on the full-voltage leads. It may be stated that, in general, the load placed on the transformers may be made equal to the full-voltage load connected, plus 0.65 of the remaining capacity of the transformers connected on the low-voltage taps, provided the low-voltage load is balanced. For example, assume that the motor load amounts to 230 kva. This leaves 300—230 = 70 kva. available. The low-voltage load may be made equal to 70 × 0.65 = 45.5 kva. before the full capacity of the transformers is reached. This calculation is only approximately correct, but the results are close enough for practical purposes.

Necessity for Removal of Air from Condenser

For operating a small engine with less back pressure, it is proposed to use a large air-cooled pipe-coil radiator as a condenser and from which the condensate could be recovered for use as boiler-feed water. Would an air pump be necessary?

C. B. O.

To obtain the benefit of operating the engine condensing by removal of back pressure, it would be necessary to employ some type of pump to remove air and uncondensable gases from the condenser.

More or less atmospheric air and other gases would be contained in the initial boiler-feed water and makeup water required for generation of steam. These, together with non-condensable gases, are liberated in the process of evaporation and are swept along with the steam through the engine to the condenser, and in addition, there are likely to be air leaks through joints in the piping between the engine and the condenser and joints of the condenser itself. Unless such gases and vapors are removed from the condenser as fast as received, there will be an accumulation of pressure that soon becomes at least as high as the pressure of the atmosphere, and to prevent the condenser pressure from rising higher than atmospheric pressure, it probably would be necessary to vent the condenser to the atmosphere.

Hence without the use of an air pump the only permanent advantage to be derived would be recovery of the condensate for use as boiler-feed water.

Higher Compression for High-Speed Engines

Why is higher compression of the exhaust used in high-speed than in low-speed engines?

R. C. L.

High-speed engines usually have their reciprocating parts heavier in proportion to the size of cylinder, and this feature combined with higher rotative speed requires more cushioning resistance for overcoming the inertia of the reciprocating parts. In addition to this requirement of greater cushioning effect, in most high-speed engines an earlier beginning of compression is necessary for obtaining a given amount of compression on account of the higher percentage of cylinder clearance which is provided for retention of any water that cannot be expelled with the exhaust during the short time per stroke the exhaust valves are open.

Throw of Eccentric

What is the "throw" of an eccentric? Is it the same as the travel or half of the travel imparted to the eccentric rod of an engine?

H. J. S.

The old English term "trow" or "throw" signifies an act of throwing or hurling or a cast, or fling; or a twist, as for instance silk "throwing" is the process of twisting together filaments of silk. According to Webster's Unabridged Dictionary the term "throw" in a mechanical sense is "the extreme movement given to a reciprocating piece by a cam, crank, eccentric or the like; travel; stroke, as the throw of an eccentric. Also the length of the radius of a crank; or the virtual radius of an eccentric, etc." Hence the term throw when applied to a crank or eccentric sometimes is used to designate the amount of rectilinear reciprocation, or is likely to be used to designate the amount the center of the crankpin or center of the eccentric is offset from the center of the shaft. Most authorities who adhere to the use of old mechanical terms, employ the word "throw" exclusively for designation of radius or eccentricity. To avoid ambiguity of understanding, it is better to omit the use of "throw" for designation of movement or travel; and for designation of the amount of offset, employ the term "radius" or "eccentricity."

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications.—Editor.]

Government Sued for Unrealized War Profits

A somewhat peculiar and interesting situation has arisen as a result of a coal company's efforts to recover from the Government the difference between the profits that it might have made and those that it was restricted to through the Government's action in diverting its coal from its regular customers.

Solicitor General Beck has filed in behalf of the Government a brief before the United States Supreme Court asking that that court sustain the decision of the Court of Claims against the suit of the Morrisdale Coal Co., which sought to recover the difference between fuel prices fixed by the Fuel Administration and those which it could have obtained under private contract.

The coal company claimed that the Government requisitioned 12,000 tons of coal from June to November, 1918, at a price less than the sale price agreed to by its former customer, and that the coal was diverted by the Fuel Administration.

The Government points out that the fuel was not actually expropriated or used for any Government purpose or requisitioned for public uses. It declines to admit its liability to make good the differences between prices fixed during Federal control and prices that might otherwise have been obtained, either in open market or under sales contracts made before the order of the Fuel Administration.

The Government insists also that the power to regulate must be unaffected and undiminished by the existence of contracts entered into prior to the advent of public control, and that contracts are subject to the possibility that the Government may render it unenforceable or impair its value. It is denied that the diversion of coal was the taking of private property for public use and binding the Government to indemnify against loss.

It is asserted that public regulation restrictive of freedom of contract and of self-controlled business management is universally imposed without provision for compensation, and that, unless property is actually taken and directly put to use for a public purpose, no duty to compensate arises, since the injury complained of results incidentally from valid exercise of Government power.

The Government points out that there is no allegation in this case that the price fixed by the Fuel Administration and received by the coal company for the diverted coal did not afford a fair return and reasonable profit on invested capital over and above cost of production and plant depreciation.

"Engineman" Changed to "Steam Engineer" in New Bill

A revised bill providing for the classification for certain civilian positions in the Government service has been introduced in the House of Representatives by Representative Lehlbach, of New Jersey. No material changes have been made in the bill previously introduced by Mr. Lehlbach, but he has yielded to the storm of protest and uses the term "steam engineers," rather than "enginemen," in referring to that class of Government employees. Mr. Lehlbach said that he favors limiting the application of the word engineer to technical engineers with professional training. He thinks the locomotive engineer should be designated as an "engine driver." His personal desire is to designate stationary engineers as enginemen or engine tenders.

Owing to the fact that the compensation schedules are to be fixed and readjusted from time to time by a board to be known as the Federal Wage Commission, there was no occasion to refer frequently to the various classifications. In the case where it was necessary to mention "steam engineers," Mr. Lehlbach used that form because of the difficulties and confusion that would be caused by the use of the word "engineer" in many state laws in applying to those whom he would term "enginemen." He said also that due consideration must be given to the general public conception of the word.

The Power Show

During the week beginning Oct. 31 there was held in Boston another of those exhibitions of power-plant appliances and materials which have come to be known as the Power Shows. In 1912, '14 and '16 such exhibitions were held under the auspices of the New England Association of Commercial Engineers as a part of the International Textile Exposition held in connection with the meeting of the National Association Cotton Manufacturers.

These expositions are held at the Charitable Mechanics' Association Building, Huntington Ave., Boston, and the last was one of the most successful of the series. Some eighty manufacturers and distributers of power-plant apparatus exhibited, and engineers and superintendents, especially those connected with the textile industries, were present in large numbers and from all over New England.

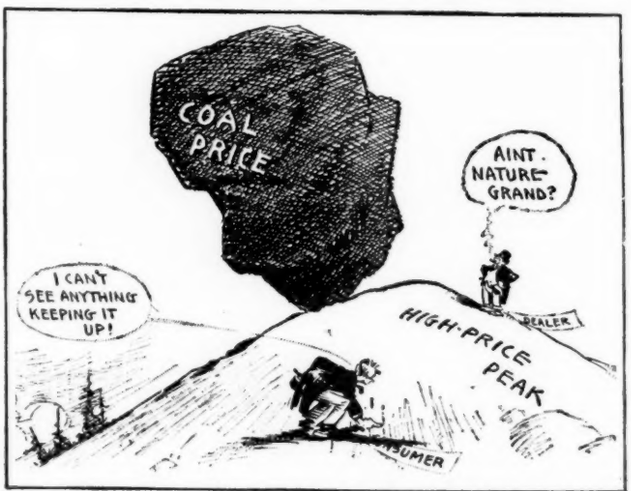
The Commercial Engineers are to be congratulated upon another achievement. Their president is Sanford C. Smith, of the McClave-Brooks Co.; Harry H. Lynch, of the Hodge Boiler Co., is vice president; Maj. James W. H. Myrick, of the Auto Force Ventilating System, treasurer; James F. Morgan, secretary. The committee in charge of the Power Show was Freemont S. Eggleston, Jr., of the Eggleston Supply Co., Major Myrick and Charles F. Ceilley, of the *National Engineer*.

Muscle Shoals Plant Leased to Alabama Power Company

Just as this issue of *Power* goes to press, word is received that Secretary of War Weeks has leased Muscle Shoals plant No. 2 to the Alabama Power Co. The lease is indefinite, however, and may be cancelled on thirty days' notice. For this reason it is understood that it does not conflict with Henry Ford's offer, as Secretary Weeks is still free to accept it and cancel the Alabama Power Co.'s lease. The terms are $10,000 a month for the plant and 2c. per kilowatt-hour.

The reason for granting the lease is undoubtedly to avert the existing power shortage in the Alabama Power Co.'s territory and thus to make it that much easier for plants that are now shut down to resume operations and bring industry back to normal.

Tests conducted at the laboratories of the United States Bureau of Standards have made it possible to work out a formula for the strength of rope. According to this formula, for three-strand regular lay Manila rope from ½ to 4½ in. in diameter, the average breaking load in pounds equals 5,000 multiplied by the diameter of the rope in inches, multiplied by the diameter of the rope increased by one. The weight that may safely be placed upon a rope, of course, is considerably less than the result so obtained, because the latter is the ultimate strength. Other data on rope are given Technologic paper No. 198, which has recently been issued by the Bureau of Standards.



THE MODERN BALANCING ROCK
Brown in the Chicago Daily News

News in the Field of Power

Brief Items from Washington

The Department of Commerce has come to the defense of the trade associations, which have recently been subjected to criticism in Washington. It is the evident feeling of the department that trade organizations in general are suffering from the questionable conduct of a very few associations. Mr. Hoover sees in the increasing success of these associations "a great and vital movement and something permanent in our economic system." Mr. Feiker, assistant to the Secretary of Commerce, says: "They are indispensable in such matters as the collection of statistics, the detailed promotion of foreign trade and in the elimination of excess variety. It is the only avenue that the Department of Commerce sees by which the Government can establish contact with a trade to the mutual advancement of fundamental interests."

Secretary Weeks is not saying very much about the Ford offer on Muscle Shoals, but he has invited Mr. Ford to confer about it in the near future. As to the proposal that the steam plant at Muscle Shoals be leased to help Southeastern power companies meet their present power shortage, he said that such an arrangement would be difficult in view of the pending negotiations. The Secretary has recently expressed the opinion that the Wilson dam could be completed for $22,000,000.

Secretary of Commerce Hoover says the coal industry, in spite of its intermittency and irregularity, is one of the most efficient industries as a whole, but is one of the most inefficient in that it gives employment for less than 165 days of the year to the total of persons employed. He says, however, that each coal mine in its equipment, engineering and efficiency of the actual men working therein will rank up to or even above any individual coal mine in any country.

The Secretary of the Interior and the Director of the Reclamation Service expect to hold a hearing in San Diego Dec. 1, at which the report of the Reclamation Service on the problems of the Colorado River will be considered. Owing to the demands made on Secretary Fall's time it has been impossible for him to conduct this hearing on the dates that have been fixed previously.

Early consideration of the bill providing for increases in salaries and certain reorganizations in the Patent Office is assured. A majority of the Committee on Rules is understood to have agreed to vote for a special rule that will bring that bill before the House for a final vote in the very near future.

Pressure-Vessel Code Will Be Considered at A. S. M. E. Annual Meeting

The Boiler Code Committee of the American Society of Mechanical Engineers has announced that good progress has been made on the proposed code for air tanks and pressure vessels, the code being intended finally to form Section 4 of the Society's Boiler Code. Those interested in the proposed rules will be given an opportunity to discuss them on the first day of the annual meeting of the society, at a hearing that will be held at 9:30 a. m. Dec. 5, in the Engineering Societies Building, 29 West Thirty-ninth St., New York City.

The committee is now preparing a revised draft of the proposed code and is making every effort to have it ready in time to distribute it among boiler and tank users and manufacturers well in advance of the hearing. It is expected also that copies will be available at the hearing.

Announcement has also been made by the committee of the completion of the set of rules for inspection of boilers of locomotives and its publication in pamphlet form. A limited edition of this pamphlet will be issued, but upon final revision will be incorporated with the Boiler Code as Section 3. The booklet is now on sale and may be obtained from the society headquarters at 29 West Thirty-ninth St., New York City, at a price of 25c. to A. S. M. E. members and 35c. to others.

Germany Standardizing on a Grand Scale

The remarkable movement for standardization in Germany, which, incidentally, was commented upon in an editorial in the Sept. 13 issue of *Power*, is discussed at considerable length in an interesting statement sent out by the American Engineering Standards Committee from its headquarters in the Engineering Societies Building, at 29 West 39th St., New York City. In that editorial attention was called to the tremendous importance that Germany now attaches to standardization and especially to the fact that, whereas Germany has previously been renowned for its efficiency in manufacture, the country now appears to be turning its attention more particularly to standardization of product. "In no other country except Great Britain," reports the American Committee, "is standardization work being carried on upon a scale or with an intensity comparable to that in Germany."

The German equivalent of our American Engineering Standards Committee is called the Normenausschuss der Deutschen Industrie, which was organized in 1917 but whose membership now comprises engineering societies, industrial associations and government ministries, and in addition, some 700 firms that are contributing members. In the short time since its establishment, this body has issued 144 approved standard sheets and has developed over 500 others which are still in tentative form. These standards are issued in loose leaf form, the Germans having been the first to use such methods. The sale of these sheets amounts to about 100,000 monthly.

The work of the Normenausschuss, which is the central body, is limited to subjects concerning two or more industries, but there are some fifteen organizations known as special industry committees which are independent from but affiliated with, the central body. Each of these committees deals with the standardization work of a single industry, and the work being done by them appears to be of as great a volume as that of the main body.

The Normenausschuss used to have a publication of its own, but now uses about sixteen pages in each semi-monthly issue of "Der Betrieb," an efficiency engineering journal with a circulation of about 8,000.

The trend in Germany appears to be toward dimensional standardization, whereas the Anglo-Saxon mind tends more toward questions of purchase and contract, such as specifications for materials, methods of test, etc. Very little of this has been done in Germany except by some of the special industry committees.

Standardization work is much more easily accomplished in Germany than in either Great Britain or the United States, which is due to the great economic pressure resulting from defeat, to the traditional German readiness to subordinate personal considerations for national ones and to the general realization of the need for standardization in accomplishing the perpetual German object in being a leader in export trade.

Life of George Westinghouse Published

An elaborate work on the life of George Westinghouse has been prepared under the direction of the American Society of Mechanical Engineers, and is to be published first in a limited subscription edition and later in a cheaper popular edition. The size and binding of the book are intended to harmonize well with other publications of the society. Orders for the subscription edition are now being received, but are accepted only from members of the four founder societies, the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers.

A popular edition will be issued later, and it is expected that copies will be available to everyone about February, 1922.

The book is evidently of an exceptional nature and will probably find a place in the libraries of most men who are actively identified with the work of the founder societies.

Oil Engine Manufacturers Organizing

The several manufacturers of heavy oil engines have effected a temporary organization for the purpose of advancing the interests of this type of prime mover. A general invitation is being extended to all manufacturers of such engines to attend a meeting in New York City Dec. 8 and 9 to complete the permanent organization and to deal with such other matters as may come before the meeting.

Recent additions to the membership of the Federated American Engineering Societies are the Vermont Engineers' Society and the Associated Engineers of Spokane.

Government Seeks Daua on Coal Stocks

The Government has been sending out questionnaires to bituminous-coal consumers throughout the country asking for information as to their stocks of coal on hand Nov. 1. The Government's expressed purpose in doing this is to ascertain exactly the amount of coal in the hands of consumers at the beginning of the winter, in order to enable consumers and producers alike to plan ahead more intelligently.

If there is any possibility that the above-ground reserves are below the safety line, the best way to settle the point, the Government thinks, is to take account of stock and lay all the facts before the public.

The information is also desirable to the public in view of the disturbance to the coal trade that may come with the renewal of the coal miners' biennial working agreement at the end of March. It is hoped to publish a preliminary report within 30 days.

Industrial Waste Report Out in Book Form

The report on waste in industry, prepared by a Committee of American Engineering Council under the direction of Herbert Hoover, has just been published in book form by the McGraw-Hill Book Co., Inc. The report was submitted to the Council in June, at which time a condensed abstract was made available to the press, and now the complete report is presented in permanent form in the name of the Committee of the American Engineering Council.

It was originally planned to investigate ten industries, but only six reports were finally completed. Investigations were started in the transportation and coal-mining industries, but it was found that they were too intricate for the time and funds available. The report on the pulp and paper industry was abandoned for the same reason, and the investigation in the rubber-tire manufacturing business was necessarily given up because the industry refused to cooperate with the committee. The six reports that were considered, and that have now been published, cover the following industries: Building trades, men's ready-made clothing, boot and shoe, printing, metal trades and textiles. Seven reports of a statistical nature were also prepared and are included in the book.

The committee in whose name the report is presented by American Engineering Council comprises the following prominent engineers: J. Parke Channing, chairman; L. W. Wallace, vice chairman; Herbert Hoover, L. P. Alford, George D. Babcock, F. G. Coburn, Morris L. Cooke, Harrington Emerson, Ira N. Hollis, Edward Eyre Hunt, C. E. Knoeppel, Robert Linton, Fred J. Miller, H. V. R. Scheel, John H. Williams, Robert B. Wolf, William Basset, Sanford E. Thompson.

The extremely high order of ability represented by this array of names is sufficient indication of the importance of the work and its significance in the growing movement to cut down inefficiency and waste in every line of life.

While the price of the book has been set at $4, it seems low when one considers what it would have had to be if the great amount of highly skilled engineering research that was devoted to the work had not been given to a large extent gratuitously.

New Publications

The Measurement of Steady and Fluctuating Temperatures. By R. Royds, M.Sc., A.M.I. Mech. E., Head of the Motive-Power Engineering Department of Dundee (Scotland) Technical College. Published by D. Van Nostrand Co., New York City, 1921. Cloth; 5½x8½ in.; 158 pages; 82 illustrations. Price, $4.

This is the first of a series of three books closely related in subject matter and method of treatment. The other two books are briefly reviewed immediately after this one, so it may be well to mention here certain common characteristics of all three. In the first case they were evidently not written for operating engineers, but rather for men engaged in engineering research work or in the design of apparatus requiring advanced knowledge of heat transfer and closely related subjects. The two latter types of readers should find all three volumes valuable for systematic study or for reference. Books of this type, being somewhat mathematical in method and containing a mass of experimental data from various sources, are of interest only to a restricted circle of readers. At the same time they greatly benefit the power industry by giving designers and research workers a better knowledge of fundamental principles, thus enabling them to develop more efficient types of apparatus.

This first book of the series covers the following subjects: Measurement of temperature; mercury thermometers; electrical thermometers and pyrometers; radiation and optical pyrometers; various other pyrometers; calibration of thermometers and pyrometers; the mean temperature of a metal wall; measurement of rapidly fluctuating temperatures.

Heat Transmisison by Radiation, Conduction and Convection. By R. Royds, M. Sc., A. M. I. Mech. E., Head of the Motive-Power Engineering Department of Dundee (Scotland) Technical College. Published by D. Van Nostrand Co., New York City, 1921. Cloth; 5½x8½ in.; 233 pages; 102 illustrations. Price $4.50.

This is the second of the series of three books whose general characteristics are discussed in the review of the first book entitled, "The Measurement of Steady and Fluctuating Temperatures." This second volume covers the following subjects: Radiation of heat; conduction of heat; convection and resistance to the flow of fluids; transmission of heat by convection.

Heat Transmission in Boilers, Condensers and Evaporators. By R. Royds, M. Sc., A. M. I. Mech. E., Head of the Motive-Power Engineering Department of Dundee (Scotland) Technical College Published by D. Van Nostrand Co., New York City, 1921. Cloth; 5½x8½ in.; 296 pages; 136 illustrations. Price, $4.50.

This is the third book of the series. The present volume covers the following subjects: Transmission of heat in boilers; condensation of steam and rate of heat transmission in certain condensers and coolers; transmission of heat in evaporators.

Personals

Morgan Olcott, formerly with Griggs & Myers, New York City, has joined William T. Donnelly, consulting engineer of New York City.

Warren G. C. Thompson is now assistant professor of mechanical engineering at the Pennsylvania State College, having resigned as chief engineer for D. G. Dery, Inc., Allentown, Pa.

Thornton Lewis, for the last fifteen years associated with the Buffalo Forge Company, and active in the heating, ventilating and air conditioning profession, has joined the York Heating and Ventilating Corp., Philadelphia, Pa., as vice president and general manager.

M. C. Mann, formerly assistant chief engineer of the Board of Education of St. Louis, Mo., has been appointed assistant chief engineer of the Gas and Electrical Division of the Missouri Public Service Commission, Jefferson City, Mo. He assumed his new duties on Nov. 1st.

H. C. Spaulding, for some time associate editor of *Power*, is with the Plant Engineering and Equipment Co., Inc., 192 Broadway, New York City, as manager of the pump department. The company manufactures steam specialties and is the Eastern agent of the Wagener Steam Pump Co., the Chicago Pump Co. and the Western Pump Co.

L. Broadus Moore, formerly manager of the Alabama division of the Georgia Alabama Power Co., is now in charge of the company's Georgia plants. Albert L. Couch has succeeded him in Alabama. Mr. Couch was for a number of years superintendent of the water and light plant of Lexington, N. C., and built the Franklin plant of the Georgia Railway and Power Co.

A. W. K. Billings has come back from Barcelona, Spain, and will act as construction manager for the English and Canadian interests controlling public-utility companies in Mexico, Brazil and Spain, and as vice-president of the Canadian Engineering Agency, Inc., 115 Broadway, New York City. He reports that the Mexican Light and Power Co. is building near Mexico City two hydro-electric plants of 52,000 hp. and is installing a 5,000-kw. turbo-generator set.

Society Affairs

Coming Conventions

National Association of Practical Refrigerating Engineers—Annual convention at Hotel Lorraine, Philadelphia, Nov. 30-Dec. 3. Secy., Edward H. Fox, 5707 West Lake St., Chicago.

Taylor Society—Annual meeting at New York City, Dec. 1-3. Managing director, H. S. Person, 29 West 39th St., New York City.

American Society of Refrigerating Engineers—Annual meeting at New York City, Dec. 5-7. Secy., William H. Ross, 154 Nassau Street, New York City.

American Society of Mechanical Engineers—Annual meeting at New York City, Dec. 5-8. Topic, "Elimination of Waste." Sec., Calvin W. Rice, 29 West 39th St., New York City.

New Britain Section, A. S. M. E., will meet Nov. 22 to hear L. P. Alford speak on "Industrial Management."

Meriden Section, A. S. M. E., will hold a meeting at the Winthrop Hotel Nov. 17, when Charles F. Leonard will speak on "Gas—Its Manufacture and Distribution."

Atlanta Section, A. S. M. E., will meet Nov. 22 for a talk on "Water Power Developments of the Southeast," by C. G. Adsit, consulting engineer with the Georgia Railway and Power Co.

St. Louis Section, A. S. M. E., is to meet Nov. 25 with the student branch of Washington University at the University for an address on "Patents and Engineering," by F. Du Pont Ammen, of Elliott & Ammen.

The Engineers Club of Philadelphia will meet Nov. 22 to hear O. C. Merrill, executive secretary of the Federal Power Commission, speak on "Accomplishments Under the Federal Water Power Act."

The Philadelphia Section, Taylor Society, will hold a joint meeting with the Society of Industrial Engineers and the Industrial Engineering Club on Nov. 28. Dr. Ira N. Hollis will speak on "Waste and Its Relation to the Industries." Dr. Hollis is a past president of the A. S. M. E. and was a member of the Elimination of Waste Committee.

The Society of Naval Architects and Marine Engineers will hold its 29th General Meeting Nov. 17 and 18 in the Engineering Societies Building. 29 West 39th St., New York City. The meeting will be held jointly with the American Institute of Electrical Engineers. There will be professional sessions at 10 a. m. each day. A paper of especial interest is "Electric Propulsion of Ships," by W. E. Thau, of the Westinghouse Co., which will be given in the afternoon of the first day.

Metropolitan Section, A. S. M. E., is to meet at the Barbour Flax Spinning Co., Paterson. N. J., on Nov. 21. Those wishing to take the trip should take an Erie R. R. train arriving at Paterson at 2:26 p. m. The reception committee will be on hand. An inspection of the factory will be made in groups of ten and will last about two hours. Afterwards there will be a dinner and lecture on Flax Spinning. James W. Cox, Jr., 320 Broadway, New York City, has charge of arrangements.

Business Items

Orton and Steinbrenner Co., 608 South Dearborn St., Chicago, Ill., has announced that Ben L. Whitney has opened offices at 528 Detroit Savings Bank Bldg., Detroit, as its representative in that territory.

Montgomery & Stock, a firm of industrial engineers, has been organized in Rochester, N. Y., by W. B. Montgomery and A. F. Stock, both of whom were previously associated with C. E. Knoeppel & Co., Inc., of New York City.

The Underfeed Stoker Company of America has appointed Edward M. Eliot assistant to the vice president. For eight years Mr. Eliot was engaged in power-plant design and construction work, and for the last seven years he has specialized in organization of service and repair work, having recently resigned as service manager for the Diamond Power Specialty Co., of Detroit.

The A. E. G. Co., of Germany, has been awarded the contract for the Deisel-electric units for the Montevideo State Electric system, Montevideo, Uruguay. The contract covers the furnishing of one 325-kw., one 175-kw., one 125-kw. and one 100-kw. engine generator units complete with all accessories. The contract was awarded for a lump sum of $139,000. This was $30,000 less than the bid of an American firm offering Westinghouse electric equipment and Taylor oil engines.

Trade Catalogs

Babbitt Metal—Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa. Folder 4474, a small booklet of instructions and cautions in pouring Westinghouse lead-base babbitt, a special alloy which the company is now placing on the market.

FUEL PRICES

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine-run) bases, f.o.b. mines):

Coal	Market Qoting	Oct. 31, 1921	Nov. 5, 1921
Pool 1,	New York	$3.25	$3.00@3.40
Pocahontas	Columbus	2.55	2.35@2.70
Clearfield	Boston	1.95	1.75@2.15
Somerset	Boston	1.90	1.60@2.15
Pittsburgh	Pittsburgh	2.15	2.10@2.20
Kanawha	Columbus	2.15	1.90@2.25
Hocking	Columbus	2.05	2.00@2.20
Pittsburgh No. 8	Cleveland	2.15	2.10@2.20
Franklin, Ill.	Chicago	2.75	2.75@3.00
Central, Ill.	Chicago	2 25	2.25@2.75
Ind. 4th Vein	Chicago	2.35	2.75@3.00
Standard	St. Louis	1.95	1.90@2 00
West Ky.	Louisville	2.45	2.00@2.40
Big Seam	Birmingham	2.15	2.00@2.25
S. E. Ky.	Louisville	2.20	2.25@2.40

New York—On Nov. 10, Port Arthur light oil 22@25 deg. Baumé, 5½c. per gal.; 30@35 deg., 7c. per gal., f.o.b. Bayonne, N. J.

Chicago—Nov. 4, for 24@28 deg. Baumé, $1@$1.10 per bbl.; 32@36 deg. 3@3½c. per gal. in tank cars f.o.b. Oklahoma refinery, or freight adjusted.

Pittsburgh — On Oct. 31 f.o.b. refienry, Pennsylvania, 36@40 deg., 6¼@6¾c. Oklahoma, 24@30 deg., $1.05 per bbl.; gas oil, 32@34 deg., 3¼@3½c. per gal., 36@38 deg., 3¾c., 38@40 deg., 4@4½c. per gal.

St. Louis—Nov. 10, prices f.o.b. cars, tank lots; 24@26 deg. Baumé, 90c. per bbl.; 26@28 deg., $1; 28@30 deg., $1.15; 32@34 deg., 2¾c. per gal.

Philadelphia—On Nov. 7, 26@28 deg. Baumé, Oklahoma, $1 per bbl.; 30@34 deg., Oklahoma (group 3), 3c. per gal.; 16@20 deg. Seabord, 3½c. per gal.

Cincinnati — Oct. 31, for 26@30 deg. Baumé, 5½c.; Diesel, 30@32 deg., 5¾c. per gal.; 32@34 deg., 6c. per gal.

Cleveland — Oct. 31, for 26@30 deg. Baumé, 4½c. per gal.

New Construction

PROPOSED WORK

Mass., Boston—The City Hospital will receive bids until Nov. 18 for two 6 story, 43 x 28 and 43 x 40 ft. and a 3 story addition to present hospital. About $500,000. Coolidge & Shatluck, Ames Bldg., Archts.

Mass., Cambridge—The Cambridge Electric Light Co., Western Ave., will receive bids until Nov. 17 for a 1 and 2 story, 70 x 192 ft. switch house. French & Hubbard, 210 South St., Archts.

Mass., Fitchburg—The School Comn. is having plans prepared for a 3 story school on Academy and Elm Sts. About $400,000. J. D. Leland Co., 366 Main St., Worcester, Archts.

Mass., Malden — The Malden Elec. Co. will soon award the contract for a 1 story, 63 x 66 ft. substation on Bway. and Oakland Sts. About $65,000. C. H. Tenney Co., 201 Devonshire St., Boston, Engrs.

Mass., Worcester — The city is having plans prepared for a high school on Grafton St. About $500,000. J. D. Leland, 41 Mt. Vernon St., Boston, Archt.

Mass., Worcester—The Masonic Protective Assn., 18 Franklin St., is having plans prepared for a 2 story 80 x 110 ft. office, club, etc., on Chestnut St. About $250,000. Frost & Chamberlain, 390 Main St., Archts.

Conn., Groton—The Independent Order Odd Fellows, plans to build a 2 or 3 story home overlooking Thames Pike. About $250,000. Architect not selected.

N. Y., Medina—The Bd. Educ. will receive bids about Feb. 1 for a 3 story, 188 x 208 ft. high school. About $450,000. W. Ittner, Bd. Educ. Bldg., St. Louis, Mo., Archt. Noted April 26.

N. Y., New York—The Bank of America, 44 Wall St., will soon receive bids for a 23 story bank and office building on Wall, William and Pine Sts. About $2,500,000. Trowbridge & Livingston, 527 5th Ave., Archts. Noted May 23.

N. Y., New York—The Bd. Educ., 500 Park Ave., will receive bids until Nov. 18 for a heating and ventilating system for P. S. No. 115 on West 176th St. between Audubon and St. Nicholas Ave. C. B. J. Snyder, Municipal Bldg., Engr.

N. J., Jersey City—The Knickerbocker Co., S. Terner, Pres., is having plans prepared for a 7 story, 65 x 125 ft. hotel on Hudson Blvd. About $600,000. W. Newmann, 314 Palisade Ave., Archt.

Pa., Bristol — The Burlington Island Amusement Co., R. Merkel, Mgr., is having plans prepared for a 300 kw. turbine lighting plant with 2 units. Miller & Baker, Pleasant Beach Park, Bridgeport, Conn., Engrs.

Pa., Philadelphia—The Bd. Educ., 19th and Chestnut Sts., is having preliminary plans prepared for four 3 story schools on 24th and Jackson Sts., Roxboro district; on 42nd and Thompson Sts.; 19th and Warrington Ave. Also additions to schools on 42and and Thompson Sts.; 19th and Reed Sts.; and 3rd and Duncannon Sts. Total cost about $3,200,000. Private plans.

Md., Cumberland — T. W. Biddle, Jr., Archt., McFarland Bldg., is receiving bids for a 12 story, 84 x 84 ft. office bldg. for the Shawanose Bldg. Co., F. S. Deacons, Pres. About $450,000.

W. Va., Brosius—The Hancock Steel Co., Hancock, Md., will receive bids about Nov. 15 for the first unit of their plant, 1 story, 130 x 200 ft. foundry and machine shop. Total cost about $3,500,000. E. McGeorge, 1900 Euclid Bldg., Engr.

W. Va., Maben—The Raleigh Wyoming Coal Co. is having plans prepared for a 70 x 80 ft. power plant. Rust Engr. Co., 1901 5th Ave., Pittsburgh, Pa., Engrs.

W. Va., Morgantown—The University of West Virginia is having plans prepared for a physical education building and a chemical laboratory. About $300,000 and $400,000 respectively. P. A. Davis, 1713 Samson St., Phila., Pa., Archt. Noted July 12.

N. C., High Point—The Methodist Protestant Church, R. M. Andrews, Chn., Greensboro, is having plans prepared for several college buildings. Cost to exceed $500,000. H. B. Hunter, Burlington, Archt.

O., Canton—The Cal-Burn Finance Co., Zinninger Bldg., Cleveland, is having plans prepared for an 11 story, 135 x 200 ft. theatre, office, bank and hotel bldg. on 3rd and Cleveland Sts., N. W. About $1,662,000. F. Swirsky, Herberich Bldg., Akron, Archt.

O., Cleveland—The Bd. Educ., F. G. Hogen, Dir., East 6th St. and Rockwell Ave., is having plans prepared for a 3 story high school on West 46th St. and Hyde Ave., about $750,000; a 3 story high school on University Circle, about $3,000,000; and a 3 story addition to high school on West 93rd St. and Willard Ave., about $800,000. Steam heating systems will be installed. W. R. McCormack, East 6th. St. and Rockwell Ave., Archt.

O., Cleveland—The city will receive bids until Dec. 1 for furnishing 8 steam turbine reduction gear driven centrifugal pumping units. R. Hoffman, City Hall, Engr.

O., Cleveland—L. W. Kelly, Hippodrome Bldg., is having plans prepared for a 10 story apartment hotel including a steam heating system on East 107th St. and Euclid Ave. About $1,500,000. G. B. Post & Sons, Hanna Bldg., Archts.

O., Mansfield—E. B. Caldwell, Jr., Archt., 884 Main St., Bridgeport, Conn., is preparing sketches for an 8 story hotel on West Park Ave. About $650,000. Owner's name withheld.

O., Toledo—The Bd. Educ. will receive bids until Nov. 23 for a 3 story high school including steam heating system on Lewis Ave. About $425,000. E. M. See, Toledo, Archt.

Mich., Detroit — The Masonic Temple Assn., Lafayette Blvd., is having plans prepared for a steam heating plant including coal and ash handling equipment for the proposed masonic temple on Temple Ave. G. D. Mason & Co., 508 Griswold St., Engrs. Noted Aug. 30.

Mich., Grand Rapids—The Kent Storage Co., Front St., N. W., plans to build a cold storage plant including complete power plant.

Ill., Amboy—The Bd. Educ. is having plans prepared for a 2 story, 107 x 189 ft. high school including a steam heating system. About $250,000. J. N. Coleman, 6257 St. Lawrence Ave., Chicago, Archt.

Ill., Centralia—The Affiliated Masonic Lodge of Centralia, c/o R. E. Hale, plans to build a 5 story lodge and office building including a steam heating system. About $250,000. Architect not selected.

Ill., Champaign — F. W. North & Co., Robinson Bldg., is having plans prepared for a 5 story apartment, including a steam heating system. About $250,000. Architect's name withheld.

Ill., Chicago—The Fanmore Hotel Corp., c/o Berlin Swern & Randell, Archts., 10 South La Salle St., is having plans prepared for a 14 story, 80 x 125 ft. hotel including a steam heating system on Jackson Ave. and Wood St. About $2,500,000.

Ill., Freeport — The Bd. Educ., c/o S. E. Raines, Supt., is having plans prepared for a 2 story high school, including a steam heating system. About $350,000. J. Royer, Flat Iron Bldg., Urbana, Archt.

Ill., Joliet—The state, c/o J. Lambert, Pres., 2095 La Salle St., Chicago, is having plans prepared for a 3 story hospital, a 4 story administration bldg. and a 3 story cell house No. 3 including steam heating systems. Total cost about $645,000. Zimmerman, Saxe & Zimmerman, 64 East Van Buren St., Archts.

Ill., Peoria — W. G. Causey, 236 South Jefferson St., is having plans prepared for an 8 story apartment, including a steam heating system. About $500,000. B. L. Hulsebus, 1232 Jefferson Bldg., Archt.

Ill., Springfield—The County Medical Society, c/o Dr. I. C. Taylor, Chn., plans to build a 4 story hospital, including a steam heating system. About $500,000. Architect not selected.

Ill., Urbana—The University of Illinois, c/o H. E. Cunningham, Secy., plans to build a 3 story office and recitation bldg., including a steam heating system. About $500,000. Architect not selected.

Ill., Zeigler—The Zeigler Ice & Bottling Co. plans to build a 1 story, 92 x 92 ft. ice plant. About $50,000. Architect not selected.

Wis., Madison—The Park Hotel Co., J. Rigby, Pres., 22 South Carroll St., has purchased a site and plans to build a 7 story, 50 x 500 ft. hotel including a steam heating and power plant on Carrol St. About $750,000. Architect not selected.

Wis., Milwaukee—The Bd. Educ., 7th and Prairie Sts., will receive bids until Nov. 17 for a 6 story, 142 x 268 ft. continuation school (2nd unit) on Prairie St. About $900,000. Van Ryn & De Gelleke, 114 Grand Ave., Archts.

Wis., Oconomowoc—F. Pabst, dairy products, is in the market for humidifier, ice machine and special machinery for dairy products including coolers, boilers, etc.

Wis., Wautoma—Dahlke, Giese & Wedki are having plans prepared for a hydro electric plant, including power house dam with 30 ft. head, pipe line, machinery, etc. Jacobson Engr. Co., 533 Metropolitan Bk. Bldg., Minneapolis, Minn., Engrs.

Wis., Whitewater—The Bd. of Normal Regents, c/o W. Kettle, Secy., Capitol Bldg., Madison, is having plans prepared for a 1 story, 60 x 150 ft. power and heating plant at the state normal school, here. About $100,000. A. Peabody, Madison, Archt. Noted Nov. 1.

Minn., Duluth—The St. Lukes Hospital Assn., E. C. Congdon, Chn. Bldg. Comn., 901 East 1st St., plans to build a 6 story, 100 x 200 ft. addition to hospital including a steam heating system on 1st St. About $750,000. Architect not selected.

Minn., Glen Lake (Hopkins P. O.)—Hennepin County Sanatorium, Dr. E. S. Mariatte, Secy., Hopkins, is having plans prepared for a 2 story power plant. About $200,000. Sund & Dunham, 512 Essex Bldg., Minneapolis, Archts.

Minn., Minneapolis—The Bd. Educ., G. F. Womrath, Bus. Supt., is having plans prepared for two 3 story junior high schools including steam heating systems, on 26th and Emerson Aves. and 14th St. and Spruce Pl. Cost about $450,000 each. E. H. Enger, 305 City Hall, Archt.

Kan., Lawrence—The Bd. Educ., c/o I. C. Stevenson, will receive bids until Nov. 22 for a 3 story school, including a steam heating system. About $495,000. W. B. Ittner, 915 Locust St., St. Louis, Archt. Noted Sept. 20.

Mo., Joplin—A. B. Thomas Fruit Co., 7th and Virginia Sts., is having plans prepared for a 4 story, 120 x 150 ft. cold storage plant on 6th and Virginia Sts. About $100,000. A. B. Thomas, Mgr. Private plans.

Mo., Lamar—The Osage Power Site Co., W. E. Banks, Mgr., is having plans prepared for a power plant to generate power from Osage River. About $3,000,000. R. Wilson, Lamar, Engr.

Mo., Montgomery City—The Montgomery City Electric Co. plans to rebuild the electric light plant. About $50,000. Architect not selected.

Mo., Osceola—The Osage Resort Co., G. Linny, Mgr., plans to build a power plant here. About $150,000. Architect not selected.

Mo., Poplar Bluff—The city, c/o S. Pottinger, Clk., is having plans prepared for setting basin and steam or electric pumping station. About $500,000. E. C. Neckey, Engr.

Mo., St. Louis—H. M. E. Pasmegoglu, 302 Chestnut St., is having plans prepared for a 2 story, 150 x 175 ft. theatre, including a steam heating system, on Delmar Blvd. and Aubert Ave. About $1,200,000. Mawran, Russell & Cornwell, Chemical Bldg., Archts.

Cal., Long Beach—The Farmers & Merchants Bank is having plans prepared for a 6 story, 100 x 150 ft. bank and office bldg. on 3rd and Pine Aves. About $300,000. W. H. Austin, 222 First Natl. Bank Bldg., Archt.

Cal. Los Angeles—The Al Malaikah Temple (J. C. Austin, 1125 Baker-Derwiller Bldg., and Edelman & Barnett, H. W. Hellman Bldg., Archts.), is having plans prepared for an auditorium on Jefferson and Royal Sts. About $1,000,000.

Cal., Los Angeles — The West Coast Theatres, Inc., c/o Milwaukee Bldg. Co., Archts., 315 Wright & Callender Bldg., is having plans prepared for a 3 story, 120 x 230 ft. theatre on Hollywood Blvd. About $500,000.

Ont., Chatham—Silverwoods Limited, A. E. Silverwood, Mgr., London, is having plans prepared for an ice making plant on Maple St. About $100,000. Private plans. Prices wanted on ice cream and refrigeration equipment.

Tex., Graham—The city, T. E. Wallace, Secy., will receive bids until Nov. 22 for waterworks improvements including pumping equipment. H. E. Elrod Co., 3206 Elm St., Dallas, Engrs.

CONTRACTS AWARDED.

N. Y., New York—The Ramsay Realty Co., c/o H. L. Young, Archt., 147 4th Ave., will build a 6 story apartment at 157th St. from St. Nicholas to Edgecombe Aves. About $500,000. D. Fredberg, Pres. Owner will build by day labor.

Pa., Erie—Director of Poor has awarded the contract for a group of buildings for the County Home including a power plant at Dobblers Farm to H. J. Conrath, Ariel Bldg. About $350,000.

Md., Cumberland—The Paragon Motor Car Co. has awarded the contract for a 1 and 2 story, 60 x 400 and 400 x 540 ft. motor car plant to W. J. Morley. About $1,000,000.

D. C., Washington—F. P. Milburn, Union Savings Bank Bldg., has awarded the contract for an 8 story apartment building on 16th St., to J. L. Parsons, Jr., Southern Bldg. About $300,000.

W. Va., Bluefield—The Bluefield College has awarded the contract for a group of 18 buildings to J. T. Pettejohns & Co., 218 8th St., Lynchburg, Va. About $750,000.

N. C., Raleigh — The State School for Blind has awarded the contract for 3 cottages for dormitories, superintendent's home, auditorium, power house and laundry, to the Carolina Constr. Co., Hamlet, $279,400. Noted Oct. 18.

O., Canton—The Canton Ice Delivery Co., 601 4th Ave., N. E., has awarded the contract for a 1 story, 80 x 92 ft. ice plant to A. F. Wendling Co., Massillon. About $100,000.

O., Cleveland—The Bd. Educ., East 6th St. and Rockwell Ave., has awarded the contract for a heating and ventilating system for the proposed school on Broadview and Spring Rds. to the Amer. Piping & Equip Co., 1869 East 55th St., $71,249. Noted Sept. 20.

O., Cleveland — B. Boyett, 1130 Spring Rd., has awarded the contract for a 1 story, 50 x 50 ft. boiler house on Spring Rd. to H. E. Klefman, 4319 Woodbridge Ave. About $25,000.

O., Dayton—B. F. Keith Theatre Assn., 1564 Bway., New York City, has awarded the contract for a 5 story, 165 x 200 ft. theatre and office bldg. on 1st and Main St. to W. N. Sutherland Bldg. Constr. Co., Syndicate Trust Bldg., St. Louis, Mo. About $800,000. A steam heating system will be installed. Noted Feb. 1.

O., Lorain—The Bd. Educ., E. Bruell, Clk., has awarded the contract for heating and ventilating systems in the proposed high schools on East 30th St. and Oakdale Ave. and East 31st and Seneca Ave. to Chappell-Warren Co., St. Clair Ave., Cleveland. Noted Oct. 11.

Ind., Lafayette—The Franciscan Sisters have awarded the contract for a 4 story, 45 x 175 ft. addition to St. Anthony hospital, also a 4 story normal school and a power plant, to E. A. Kimmer, 4th and South Sts. About $600,000.

Mich., Crystal Falls — The Peninsular Power Co. will build a 1 story, 50 x 130 ft. electric sub-station. About $60,000. Mead and Seastone, Archts. Owner will build by day labor.

Mich., Wyandotte — The Bd. Educ. has awarded the contract for a 3 story school to F. R. Patterson Constr. Co., 1921 Ford Bldg., Detroit, about $1,000,000. A steam heating plant and mechanical ventilating system will be installed.

Ill., Chicago—The Fullerton Plaza Bldg. Corp. has awarded the contract for a 5 story, 64 x 192 ft. apartment hotel on Fullerton Pkway. to Welch-McCarthy Constr. Co., 56 East Washington St. About $500,000. A steam heating system will be installed.

Ill., Harrisburg—The Bd. Educ., c/o G. Davenport, Pres., has awarded the contract for a 2 story, 140 x 140 ft. high school to Murch Bros., Railway Exchange Bldg., St. Louis, Mo. About $300,000. Noted Oct. 4.

Wis., Kenosha—The Winther Motor Co., North Shore Rd., has awarded the contract for a 1 story, 61 x 386 ft. factory building to the Truscon Steel Co., 216 West Water St., Milwaukee. About $250,000. A steam heating system will be installed.

Ark., Fort Smith—The Ft. Smith Light & Traction Co., D. C. Green, Mgr., will build a 2 story, 100 x 120 ft. addition to power house with cooling towers on River and North D Sts. About $125,000 not including equipment. Work will be done by day labor. Byllesby Eng. Corp., 208 South La Salle St., Chicago, Ill., engrs., will receive bids for 5,000 kw. steam turbine and generator.

Okla., Oklahoma City — The Oklahoma Club, c/o J. Shartel, Pres., has awarded the contract for a 6 story 125 x 140 ft. club house to C. M. Dunning Constr. Co., Herskowitz Bldg. About $350,000. Steam heating system will be installed. Noted Nov. 1.

Okla., Sayre—The city has awarded the contract for electrical improvements, waterworks and sewers, to the Ajax Constr. Co., Lawton, $72,500. Noted Oct. 4.

Ont., Galt—The Galt Arena, Ltd., W. G. Fallen, Mgr., has awarded the contract for an 80 x 200 ft. arena to the Tory Contracting Co. About $80,000. Prices wanted on ice making equipment.

Que., Quebec—The Canadian Pacific Ry., Windsor Station, Montreal, has awarded the contract for a 17 story extension to the Chateau Frontenac hotel to Anglin & Norcross Co., Ltd., Victoria St., Montreal. Cost plus percentage basis.